BONNEVILLE PROJECT
AND
TRANSMISSION SYSTEM

ALLOCATION OF COSTS

AS BASIS FOR
SCHEDULES OF RATES AND CHARGES
FOR ELECTRIC ENERGY

REPORT OF THE CHIEF ENGINEER
TO THE COMMISSION

WASHINGTON
JUNE 1945

Federal Power Commission

Bonneville Project and Transmission System

ALLOCATION OF COSTS

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Exhibits

Bonneville Project and Transmission System

ALLOCATION OF COSTS
As Basis for Schedules of Rates and Charges
For Bonneville Electric Energy

Predicated upon the Completed Installation in the Bonneville Power Plant
Ten Main Generating Units, Rated Capacity 518,400 Kilowatts
Maximum Capability 582,000 Kilowatts
Transmission Facilities as Required by Bonneville Act

TO: Federal Power Commission

SUBJECT: Allocation of Costs, Bonneville Project
Columbia River, Oregon-Washington

1. Under the provisions of an Act of Congress approved August 20, 1937 (50 Stat. 731), Public 329, 75th Congress, hereinafter called the Act, it is the duty and responsibility of the Federal Power Commission to make an "allocation of costs"[1/], upon the basis of which schedules of rates and charges for the sale of electric energy generated at the Bonneville project shall be prepared, fixed, and established. Included in such allocation of costs will be the entire cost of the facilities provided solely for power purposes at the Bonneville project; the entire cost of the electric transmission lines and substations, and appurtenant facilities, required by Section 2(b) of the Act; and such share, if any, of the costs of those facilities at the Bonneville project having joint value for power development and other purposes, as the Commission may allocate to electric facilities[2/]. In the process of making the

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1/ "Rate schedules shall be based upon an allocation of costs made by the Federal Power Commission" -- Section 7 of the Act.

2/ Last sentence of Section 7 of Act.

aforementioned allocation of costs, the Commission will necessarily determine, as nearly as may be, "the cost of producing and transmitting such electric energy, including the amortization of the capital investment over a reasonable period of years", as required by the Act.

2. Under Section 6 of the Act schedules of rates and charges prepared by the Administrator must be confirmed and approved by the Federal Power Commission before they may become effective.

3. In view of the interrelationship between Sections 6 and 7, and for the convenience of the Commission, the full text of these two sections is quoted below:

> Sec. 6. Schedules of rates and charges for electric energy produced at the Bonneville project and sold to purchasers as in this Act provided shall be prepared by the administrator and become effective upon confirmation and approval thereof by the Federal Power Commission. Subject to confirmation and approval by the Federal Power Commission, such rate schedules may be modified from time to time by the administrator, and shall be fixed and established with a view to encouraging the widest possible diversified use of electric energy. The said rate schedules may provide for uniform rates or rates uniform throughout prescribed transmission areas in order to extend the benefits of an integrated transmission system and encourage the equitable distribution of the electric energy developed at the Bonneville project.
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> Sec. 7. It is the intent of Congress that rate schedules for the sale of electric energy which is or may be generated at the Bonneville project in excess of the amount required for operating the dam, locks, and appurtenant works at said project shall be determined with due regard to and predicated upon the fact that such electric energy is developed from water power created as an incident to the construction of the dam in the Columbia River at the Bonneville project for the purposes set forth in section 1 of this Act. Rate schedules shall be drawn having regard to the recovery (upon the basis of the application of such

> rate schedules to the capacity of the electric facilities of Bonneville project) of the cost of producing and transmitting such electric energy, including the amortization of the capital investment over a reasonable period of years. Rate schedules shall be based upon an allocation of costs made by the Federal Power Commission. In computing the cost of electric energy developed from water power created as an incident to and a byproduct of the construction of the Bonneville project, the Federal Power Commission may allocate to the costs of electric facilities such a share of the cost of facilities having joint value for the production of electric energy and other purposes as the power development may fairly bear as compared with such other purposes.

4. Section 1 of the Act provides for the completion, operation, and maintenance of the Bonneville project "for the purpose of improving navigation on the Columbia River, and for other purposes incidental thereto". Power development is the only other purpose mentioned in the Act, and it appears that no other incidental purposes are directly served by the project[1/]. Flood-control benefits are negligible, and no plan or suggestion has been advanced for using the impounded waters for irrigation purposes. Irrigation is practiced but little if at all in the valley below the dam.

Definitions

5. The term "Bonneville project" means "the dam, locks, power plant, and appurtenant works" constructed by the United States on the Columbia River at Bonneville, Oregon, and North Bonneville, Washington (Section 1 of Act).

1/ During the early part of the construction period the project contributed moderately to unemployment relief; hence that purpose was served temporarily. It might be observed also that the project proved to be very valuable for the purposes of national defense.

6. "Bonneville transmission system" means the electric transmission lines and substations, and facilities and structures appurtenant thereto, which the Administrator is authorized and directed by Section 2(b) of the Act to construct or otherwise provide for the purposes set forth in the Act.

7. The term "electric facilities" means all of the electric power facilities and related general facilities required by the Act for the generation and for the transmission and sale or interchange of all electric energy that can be generated at the Bonneville project in excess of the amount required for operating the dam, locks, and appurtenant works at said project.

8. "Bonneville Power Administration" (abbreviated BPA) is the name given to the office and organization established in the Department of the Interior for the administration of the Act, under the supervision of the Administrator (see references in Appropriation Act for fiscal year 1941, 54 Stat. 410, and subsequent appropriation acts; also in Executive Order 8526).

Interest Rate and Amortization Period

9. In the preparation of this report an interest rate of 2.5 percent per annum[1/] has been used for all purposes involving interest calculations in connection with the Bonneville project and the Bonneville transmission system, and 50 years, beginning July 1, 1944, adopted as

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1/ This interest rate approximates the average weighted cost of money to the United States obtained by the issuance of bonds during the 11-year period, 1933 to 1943.

a "reasonable period of years" over which to recover the Government's capital investment in electric facilities, as required by Section 7 of the Act. Use of both the 2.5-percent interest rate and the 50-year amortization period has been agreed to by the Bonneville Power Administration and approved by the Commission.

General Information

10. The Bonneville project was constructed and is being maintained and operated by the Corps of Engineers, U. S. Army (U. S. Engineer Department), under the direction of the Secretary of War and the supervision of the Chief of Engineers. The power output is delivered at the plant bus to the Bonneville Power Administration and is transmitted and marketed by that agency under the direction of the Secretary of the Interior and the supervision of the Administrator. Under Presidential Executive Order 8526, dated August 26, 1940, the Bonneville Power Administration is also responsible for the transmission and sale of electric energy generated at the Grand Coulee project. In addition to transmission facilities thus far constructed or otherwise provided by the Administrator for marketing Bonneville power, a larger system has been partially constructed, principally in the State of Washington, for marketing the Grand Coulee power output.

11. Construction of the Bonneville project was commenced on or about October 1, 1933, under the National Industrial Recovery Act, as Public Works Administration Project No. 28. It was specifically authorized by Congress in the River and Harbor Act approved August 30, 1935.

The dam and ship lock were practically completed by June 30, 1938, and the installation of generating equipment in the hydroelectric power plant was completed in December 1943, when the tenth and last main generating unit commenced operation. It has been estimated that as of July 1, 1944, 97.8 percent of the Bonneville project costs had been incurred. Temporary deferment during the war period of work yet to be done results in no appreciable functional impairment of any of the project works.

12. Although it had long been recognized that a dam below Cascade Rapids would be an essential feature of any acceptable general plan for development of the water resources of the Columbia Basin, the commencing of construction of the Bonneville project in the autumn of 1933 was occasioned by the efforts of the Federal Government to relieve the prevailing widespread unemployment in the country, and promote recovery from a business depression of unprecedented severity. The work was started before project plans were prepared or exact locations for the project structures determined, and this procedure, while deemed justified in the circumstances, apparently resulted in somewhat higher project costs than might normally have been expected.

13. The Bonneville dam, power plant, and ship lock are located in and across the Columbia River at Bonneville, Oregon, and North Bonneville, Washington (Mile 145.3)[1/], in Multnomah County, Oregon, and Skamania County, Washington, at Bradford Island near the foot of

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1/ Mileage figures indicate river distance above the mouth of the river.

Cascade Rapids, and at the head of tidewater; about 42 miles easterly from Portland, and 44.1 river miles below The Dalles.

14. The Columbia River rises in Columbia Lake, British Columbia, on the western slope of the Rocky Mountains, and flows in a northwesterly direction about 200 miles to the mouth of Canoe River at the bight of the Big Bend, where it makes an abrupt turn to the south, passes the city of Revelstoke, B. C., flows through very long flat-slope expansions known as Upper Arrow Lake and Lower Arrow Lake, and after being joined first by the Kootenay River and then by the Pend Oreille River, crosses the International Boundary into the State of Washington about 10 miles below Trail, B. C. The river distance from Columbia Lake to the International Boundary is 460 miles. Below the International Boundary the river flows in a general southerly direction entirely across the eastern end of Washington, and from a point about 15 miles below the mouth of Snake River, flows westerly to the Pacific Ocean, forming the boundary between Washington and Oregon. The river distance from the International Boundary to the sea is 750 miles, and the fall in this distance is 1,288 feet, only about 10 feet of which is below the Bonneville dam. The Grand Coulee reservoir occupies the 151 miles of river immediately below the International Boundary.

15. The river drains an area of 259,000 square miles, of which 220,000 square miles is in the United States. Its principal tributaries in Canada are the Kootenay and Pend Oreille Rivers; and in the United States, the Snake, Willamette, Cowlitz, Spokane, Deschutes, Lewis, Yakima, Okanogan, Wenatchee, Chelan, and John Day Rivers.

Stream Flow at Bonneville

16. During the 65-year period ended September 30, 1944, the flow of the Columbia River at Bonneville is estimated to have ranged from a minimum of 35,000 cubic feet per second (abbreviated c.f.s.) on January 8, 1937, to a maximum of 1,170,000 c.f.s. on June 6, 1894, at the peak of the greatest flood of record. The average flow at Bonneville during this 65-year period was 205,500 c.f.s.

17. The record high and low flows are now only of historical interest, as existing storage in the basin, principally at Grand Coulee but also at Flathead, Kootenay, and Chelan Lakes, will result in a more nearly uniform flow in the future. It may reasonably be expected, however, that hereafter the average flow at Bonneville will approximate the 205,500 c.f.s. heretofore experienced, or perhaps be slightly less on account of the increasing use of water for irrigation purposes.

The Project Works

18. The Bonneville project works consist of the dam and reservoir, ship lock, power plant, fishways, and appurtenant works, including transformers and other electrical equipment necessary for delivery of the power output to the Bonneville Power Administration.

19. Exhibit 1 herewith shows the entire stretch of the Columbia River affected by the Bonneville project; also the project works on a site map; cross sections through the ship lock, spillway dam, and powerhouse; a sketch plan of the ship lock; and a small scale map indicating the extent of lands acquired by the United States for project purposes.

Exhibit 2 is an aerial photograph of the project works, taken from the Oregon side of the river and from a point a short distance upstream from the project works. The spillway dam is near the right side of the photograph, and the power plant and ship lock are in the left foreground.

20. The dam is a gravity-type concrete spillway structure, with crest or gate sills at elevation 24. It extends across the main channel, from the Washington shore to Bradford Island, and is 1,090 feet long. It has a base width of about 200 feet and a maximum height of 170 feet. Piers 10 feet thick and spaced 60 feet center to center provide 18 gate openings, each 50 feet wide. The normal operating level of the reservoir is elevation 72; but the spillway gates, supplemented by stop logs as a wartime expedient, permit of temporary operation at levels up to elevation 78[1/]. The spillway has flood discharge capacity of 1,600,000 c.f.s., which is 37 percent greater than the peak discharge of the record flood of 1894.

21. The ship lock, with chamber width of 76 feet and clear length of 500 feet, lies along the Oregon shore. The depth over the lower sill at extreme low water is 24 feet. Since completion of the lock late in 1937 it has been possible for ocean-going vessels to ascend the Columbia River to The Dalles (Mile 189.4). Under normal operation, with pool elevation of 72, the maximum lift of the lock is about 62 feet. With the reservoir at elevation 78, as at present, the maximum lift is about 68 feet. No large lock in existence has a higher lift.

1/ The present top-of-gates elevation is 79.

22. The powerhouse extends across Bradford Slough[1/] from the river wall of the lock to Bradford Island. It is about 1,500 feet downstream from the spillway dam, and an earth dike on the island connects it with the dam, thus completing the barrier. The powerhouse is equipped with ten main generating units, two of which have rated capacity of 43,200 kilowatts each and the remaining eight, 54,000 kilowatts each, at 0.9 power factor; but these are merely nominal capacities. Actually the two smaller main units are capable of generating 55,000 kilowatts each and the larger units, 59,000 kilowatts each. In addition there is a 4,000-kilowatt house unit which is not operated for commercial purposes. The ten main generating units, with combined maximum capability of 582,000 kilowatts, are available for commercial operation. It is expected that they will operate under a head of from 68 to 70 feet during periods of extreme low flow, with the reservoir at elevation 78 to 80.

23. Each main generating unit is driven by a 5-blade Kaplan propeller-type runner, the blades being automatically adjusted by governor control to the pitch or angle of best efficiency. There is nothing unusual about the generators except their large size.

24. Three-phase 60-cycle current is generated at 13,800 volts, nearly all of which is stepped up by transformers, located on the upper deck of the powerhouse, to 115,000 volts or 230,000 volts, as desired by the Bonneville Power Administration for transmission. The high-tension switching equipment is on the roof of the powerhouse.

1/ Bradford Slough is the name applied to the chute of the river between Bradford Island and the Oregon shore.

25. Four fish ladders and three fish locks, referred to collectively as fishways, provide for the migrations of fish back and forth past the dam. One of the fish ladders is at the Washington end of the spillway dam; another is on Bradford Island at the other end of the dam; a third starts at the powerhouse, extends to Bradford Island, and thence to the upper pool; and the fourth, which is detached from the other project structures, is on the Oregon side of the river. Fish locks are located at either end of the spillway dam, and adjacent to the river wall of the ship lock. These locks operate like navigation locks.

Pool Elevations

26. The Bonneville project was designed for normal operation of the reservoir at elevation 72, but with provision for it to rise above elevation 80 for brief periods during great floods, when the tailwater would also be very high. At present the reservoir is being operated at elevation 78 as a war emergency measure, but the Office of the Chief of Engineers has ruled that after the emergency has passed, normal operation at elevation 72 shall be resumed.

27. It is assumed, after discussion with the Deputy Chief of Engineers, that in event of grave national emergencies in the future, the reservoir will be operated as at present if necessary; that is, at elevation 78, or possibly at elevation 80. It would appear that a recurrence of the record low-flow conditions of 1936-37 would constitute an emergency justifying operation of the reservoir at the higher level, but necessity for doing this is not expected to arise more than twice during the next fifty years.

Bonneville Project Costs[1/]

28. Bonneville project costs incurred to June 30, 1944, including interest during construction at the rate of 2.5 percent per annum, are as follows: For navigation facilities, $5,784,055.16; for power facilities, $37,681,648.33; and for facilities having joint value for navigation and power development, $40,243,726.84. Additional costs estimated to be necessary after June 30, 1944, to complete the project, including interest during construction on the same basis, are as follows: Navigation facilities, $750,459.94; power facilities, $658,613.02; and joint facilities, $492,368.62. Combining these figures, the anticipated final project costs may be stated as follows:

Navigation Facilities	$ 6,534,515.10
Power Facilities	38,340,261.35
Joint Facilities	40,736,095.46
Grand Total	$85,610,871.91

29. Included in the costs incurred through June 30, 1944, is interest during construction as follows: Navigation facilities, $292,972.28; power facilities, $1,258,782.59; and joint facilities, $1,980,775.33.

30. Included in the anticipated final costs shown above is interest during construction as follows: Navigation facilities, $302,237.22; power facilities, $1,266,913.61; joint facilities, $1,986,853.95; total, $3,556,004.78. The project costs are shown in greater detail on Exhibit 3, to which attention is invited.

1/ Gross capital expenditures, plus interest during construction.

31. The base costs were taken from the records of the U. S. Engineer Department at the U. S. Engineer Office, Portland, Oregon, by the Commission's supervising accountant of the San Francisco Regional Office, who was detailed to duty temporarily with the Chief Engineer on this investigation. He computed the interest during construction as shown in this report. The Bonneville project costs are kept accurately and capably by the U. S. Engineer Department, in accordance with this Commission's Uniform System of Accounts, as reported to the Chief Engineer by the supervising accountant.

Transmission

32. Construction of transmission facilities for marketing electric energy generated at the Bonneville project in the manner contemplated by Section 2(b) of the Bonneville Act was commenced by the Administrator during the fiscal year 1939, and the system necessary for this purpose was about 70 percent completed by July 1, 1944.

33. By Executive Order 8526, dated August 26, 1940, the President designated the Bonneville Power Administrator as marketing agent responsible for the transmission and sale of power and energy generated at the Grand Coulee project in excess of power requirements for operation of that project, including its irrigation features. The Administrator has since been marketing power produced at both the Bonneville and Grand Coulee projects over transmission facilities constructed under his supervision, with funds appropriated for the Bonneville Power Administration. Combined BPA expenditures for transmission lines and

substations, and facilities and structures appurtenant thereto, required by Section 2(b) of the Act, and similar facilities constructed under Executive Order 8526, totaled $76,106,309[1/] as of July 1, 1944, as reported by BPA, and that agency expects the ultimate capital cost thereof to exceed $164,000,000.

Costs Already Incurred for, and Estimated Ultimate Cost of, Bonneville Transmission Facilities Required under Section 2(b) of Act

34. At the request of the Chief Engineer of this Commission, the Bonneville Power Administration made a study for the purpose of determining the probable ultimate capital cost of the transmission system required by the Act for marketing the total power output available for sale from the Bonneville plant. The results of this study were well presented by the Chief of the BPA System Development Section in a memorandum dated July 19, 1944[2/]. Accompanying the memorandum are two exhibits entitled "Transmission System for Marketing Power from Bonneville Dam", showing the existing and proposed facilities, both geographically and diagrammatically. In making this study, the Bonneville-Grand Coulee transmission facilities referred to above were divided into two principal parts, one for marketing Grand Coulee power and the other for marketing Bonneville power. It was found that the division follows natural lines, and that the Bonneville portion "includes the area which under postwar conditions can easily absorb the total output from Bonneville".

1/ Gross expenditures to July 1, 1944, $76,106,309, comprised of: Net plant in service, $69,978,467; retirements, $1,147,481; and construction work in progress, $4,980,361.

2/ Exhibit 4 attached to this report.

35. The capital costs of the transmission facilities were taken from BPA Work Order records covering those facilities already constructed and under construction, and from engineering estimates with respect to facilities planned for construction to complete the Bonneville transmission system.

36. Due principally to wartime restrictions applying to materials and manpower, the transmission system required by the Act has not advanced to the stage that might reasonably have been expected under normal conditions. It has been found impossible during the past three years to build certain feeder lines or to complete substations and other facilities according to normal standards. Large expenditures for accomplishing these purposes, particularly for the installation of additional transformer capacity and synchronous condensers in existing substations, and related facilities required to complete the system, will be necessary, but it is probable that the greater part thereof will be deferred until after termination of the war.

37. A summary of the BPA estimate of the cost of the Bonneville transmission system is shown below:

Summary

Total Investment in Transmission and General Facilities

1.	230-kv lines and substations	$12,851,960
2.	115-kv lines and substations	20,095,279
3.	Subtransmission	2,891,658
4.	Miscellaneous customers' connections	1,250,000
5.	Subtotal	$37,088,897
6.	Substation, site, and building improvements . .	2,804,344
7.	¼ Estimated cost proposed Administration Bldg. .	912,500
8.	Other capital investments (5% of Item 5)	1,854,445
9.	Total	$42,660,186

38. Information regarding the facilities listed above, and the estimated cost thereof, may be seen in greater detail by reference to Exhibit 4 herewith.

39. At the time the aforementioned study was made, it was expected by the BPA staff that the transmission facilities then constructed and under construction in the Bonneville market area (see drawing 24992 attached to said memorandum dated July 19, 1944 — Exhibit 4 of this report), as covered by BPA Work Orders and engineering estimates, would cost $30,794,561. Actual capital costs incurred therefor to and including June 30, 1944, totaled $29,677,921. Between June 30, 1944, and March 4, 1945, BPA incurred additional costs in the amount of $80,989, and on the latter date estimated that still further expenditures totaling only $1,100 would be required to complete the facilities, making the total cost thereof $29,760,010, or 3.36 percent less than the estimated cost of $30,794,561.

40. Included in the BPA costs incurred to June 30, 1944, ($29,677,921), is the entire cost of the two Bonneville-Vancouver 230-kv transmission lines, $1,971,277. These facilities are not used exclusively by the Bonneville project, although at times of monthly peak demand nearly three-fourths of the power carried thereby has on occasion come from Bonneville. Obviously it would not be equitable to charge the entire cost of these lines against the Bonneville transmission system, but in view of the fact that they are primarily Bonneville facilities, and after consideration of other relevant facts,

it has been concluded that three-fourths of such costs might justifiably be borne by Bonneville. Hence, to give effect to this change, $492,819 should be deducted from the costs incurred to June 30, 1944, as reported by BPA.

41. Included also is the entire cost of the Vancouver-Kelso 230-kv line, $1,720,360. This line, like the two Bonneville-Midway lines, half the cost of which is to be borne by the Bonneville transmission system, serves to connect the Bonneville power system with the Grand Coulee system. It is deemed consistent and reasonable, therefore, to give to the Vancouver-Kelso line the same treatment as that accorded the two Bonneville-Midway lines; that is, charge half of the cost thereof against the Bonneville transmission system. Hence, a deduction of $860,180 from the BPA costs as of June 30, 1944 ($29,677,921), appears reasonable.

42. The sum of the deductions from the costs incurred to June 30, 1944, for 230-kv facilities, as treated separately in paragraphs 40 and 41 above, is $1,352,999.

43. It will be observed that the Bonneville Power Administration has included an item of $912,500 in the cost of facilities which that agency proposes be charged to the Bonneville transmission system, this amount representing one-fourth of the estimated cost of a new administration building which BPA desires to construct in Portland. BPA is now renting all or parts of seven different buildings in Portland, and it is believed that the rent paid therefor, together with

the cost of maintaining taxicab service between buildings, the value of time lost in going from building to building, and other expense incidental to the occupancy of so many buildings in different parts of the city, would abundantly justify the construction by the United States of a suitable administration building. However, the rents and all of the other costs referred to above are provided for in the BPA estimate of annual financial requirements (annual costs) for the Bonneville transmission system, and the estimated unit cost of Bonneville energy is based in part upon such annual costs. If the Administration building should be constructed, the annual costs thereon would be less than the corresponding expense now being borne by BPA due to the fact that no such building is available. Hence no part of the estimated cost of the building should now be charged to the Bonneville transmission system. When the building is constructed, an appropriate part of its cost may be charged thereto, but this will result in no increase in Bonneville's financial burden.

44. Item 8 of the BPA summary, $1,854,445, is simply 5 percent of the Item 5 subtotal of $37,088,897. In view of the deduction of $1,352,999 from the costs of 230-kv facilities and hence from the $37,088,897, a corresponding revision of Item 8 might appear to be in order. Upon the assumption, however, that the $1,854,445 is a judgment figure, deemed by the BPA staff as desirable for inclusion to cover contingent costs not now predictable, this amount is left in the estimate.

45. Although no deductions from the costs incurred by BPA for 115-kv facilities are being made, it seems well to point out that the Rainier-Longview lines Nos. 1 and 2 are not used exclusively for marketing Bonneville power.

46. Other joint-use facilities, the entire cost of which is charged to the Bonneville transmission system, are the switching facilities at North Bonneville and at the J. D. Ross substation and the warehouse and shop at the latter substation.

47. Since the study referred to above was completed, the BPA staff has advised the Chief Engineer that $757,000 should be added to the estimate to cover certain incremental capital costs necessary to provide tap lines and substation facilities for making available a substantial part of the Bonneville secondary energy for servicing electric boilers expected to be used principally by the pulp and paper industry, this amount being in addition to allowances previously made in the estimate for the delivery of secondary energy to other classes of customers.

48. Giving effect to the changes dealt with in paragraphs 39 to 43, inclusive, and paragraph 47, the estimated cost of the Bonneville transmission system and related general facilities may be stated in revised form as follows:

Revised Cost Summary
Bonneville Transmission System and Related Facilities

A. Facilities constructed or under construction as of June 30, 1944:

1. Actual costs to and including June 30, 1944, as reported by BPA . .	$29,677,921	
2. Deduction (see paragraph 42)	1,352,999 [1]	
3. Costs incurred to and including June 30, 1944, chargeable to Bonneville transmission system . . .	$28,324,922	
4. BPA estimate of costs necessary for completion of those facilities covered by Item 1 above which were incomplete as of June 30, 1944 .	82,089	
5. Indicated final cost of Bonneville transmission system facilities constructed or under construction as of June 30, 1944		$28,407,011

B. Facilities the construction of which had not been commenced as of June 30, 1944:

1. BPA estimate of the cost of such facilities	$12,622,625 [2]	
2. Deduction (see paragraph 43)	912,500	
3. Revised estimate		11,710,125

C. Revised estimate of cost of Bonneville transmission system and related facilities $40,117,136

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[1] This $1,352,999 was deducted from the costs of 230-kv transmission lines the construction of which was completed prior to June 30, 1944.

[2] $42,660,186 plus $757,000, minus $30,794,561. The cost of facilities constructed or under construction as of June 30, 1944, was estimated by BPA at $30,794,561. Items B-1 and B-3 above include the $757,000 referred to in paragraph 47.

49. It is probable that the total of $40,117,136 shown above is more money than will be required to provide a transmission system, with the necessary appurtenant facilities, to meet the requirements of the Act in all respects. The reasons prompting this statement are as follows: (a) the estimate includes a large arbitrary item of $1,854,445 in the nature of a provision for contingencies; (b) with the Bonneville transmission system more than 70 percent completed, experience has shown the actual costs to be 3.36 percent less than the BPA estimate; and (c) it is expected that practically all of the remaining costs will be incurred after termination of the present war, when the construction cost level will probably be lower than at present. It is recommended, therefore, that the Commission proceed under the assumption that the aggregate cost of the transmission lines and substations, and facilities and structures appurtenant thereto required by Section 2(b) of the Act, will be $40,000,000.

50. Costs incurred to and including June 30, 1944, for Bonneville transmission facilities as reflected in the revised cost summary, paragraph 48 above, total $28,325,000 in round figures. Deduction of this figure from the assumed ultimate cost of the Bonneville transmission system ($40,000,000) leaves $11,675,000 as the indicated amount necessary to be expended in the future to complete the system. It is assumed that this remaining investment will be made during the five fiscal years 1945 to 1949, as follows:

1945	$ 82,000
1946	1,000,000
1947	3,700,000
1948	4,500,000
1949	2,393,000
Total	$11,675,000

Commission's Interim Allocation Order
of February 8, 1938

51. The rate schedules now in effect were fixed and established after announcement of the Commission's interim order of February 8, 1938, which was adopted at a time when only two of the ten main generating units had been installed, and when it was "impossible to determine . . . the cost of the remaining eight generating units, representing about 80 percent of the probable ultimate installation", or of the completed Bonneville project. The Commission made a conditional determination in said interim order to the effect that ultimately power development may fairly bear 32.5 percent of the cost of facilities having joint value for the production of electric energy and other purposes, "this percentage being subject to revision and readjustment by the Commission from time to time, on the basis of facts and circumstances obtaining at any time".

52. Inasmuch as the Bonneville project is substantially completed, with its "ultimate" power installation in operation, and the Bonneville transmission system is well advanced toward completion, it appears that the Commission's interim allocation of costs made early in 1938, before any costs had been incurred for transmission facilities, should now be superseded by a Commission determination and allocation of costs made on the basis of the facts and circumstances obtaining at this time, and taking into consideration estimates of capital costs yet to be incurred.

Controlling Provisions of the Act

53. Under this heading reference will be made to those provisions of the Act which seem to require consideration by the Commission in the discharge of its principal responsibilities under the Act, particularly the making of an allocation of costs, as a basis for fixing and establishing schedules of rates and charges for the sale of Bonneville power, and the related matter of confirming and approving rate schedules prepared by the Administrator. Such comment and discussion will be inserted as may seem to be appropriate.

54. In Section 1 of the Act, the Congress authorized and directed the completion, operation, and maintenance of the dam, locks, power plant, and appurtenant works (which Congress called the Bonneville project), then under construction on the Columbia River at Bonneville, Oregon, and North Bonneville, Washington. It is stated therein that the Bonneville project as thus authorized is "for the purpose of improving navigation on the Columbia River, and for other purposes incidental thereto". Thus, with this legislative determination, the question as to the primary purpose of this project is a settled matter.

55. One of the "other purposes" for which the project was constructed is first revealed in Section 1, where provision is made for a power plant, as an important feature of the project works -- a facility "for the generation of electric energy" 1/.

1/ No other incidental purpose is mentioned in that Act.

56. In Section 1 reference is also made to the "Bonneville power administrator", and in Section 2(a) appointment of the Administrator by the Secretary of the Interior is authorized and directed; and the Administrator's duties are specified. Among other things he is charged with responsibility for making arrangements for the transmission and sale of all electric energy generated at the Bonneville project, except the part thereof required for the operation of the project works.

57. In Section 2(b) of the Act the Administrator is authorized and directed "to provide, construct, operate, maintain, and improve such electric transmission lines and substations, and facilities and structures appurtenant thereto, as he finds necessary, desirable, or appropriate for the purpose of transmitting electric energy, available for sale, from the Bonneville project to existing and potential markets, and, for the purpose of interchange of electric energy, to interconnect the Bonneville project with other Federal projects and publicly owned power systems now or hereafter constructed." Here is found a specific requirement of the Congress that the Administrator provide a transmission system. For what purpose? For the transmission and sale or interchange of electric energy generated at the Bonneville project; to encourage the widest possible use of all electric energy that can be generated at Bonneville; to provide reasonable outlets for such energy; and to prevent the monopolization thereof by limited groups.

58. In Section 3 of the Act, the Congress defines the terms "public body" and "cooperative", and in Section 4 provides that at all

times in disposing of electric energy generated at the Bonneville project, the Administrator shall give preference and priority to public bodies and cooperatives. Such public bodies and cooperatives supply electric service to their members as nearly as possible at cost. Clearly, it was the intent of the Congress that the electric energy generated at the Bonneville project be disposed of to these public bodies and cooperatives, and to other purchasers, as nearly as possible at cost. In providing for the production of electric power at the Bonneville project, it was not the intent of the Congress that the Federal Government should profit thereby at the expense of the people within economic transmission distance of the power plant; and it is equally clear, as will appear hereinafter, that it was the intent of the Congress that the power output of the Bonneville project should not be sold below cost.

59. The Congress, as appears from Section 4(d) of the Act, contemplated supplying electric service, particularly through public bodies and cooperatives, to the people of the States "within economic transmission distance of the Bonneville project".

60. In Section 5(a), the Act refers to such rate schedules as the Federal Power Commission may approve, and subject thereto clothes the Administrator with power to negotiate and enter into contracts for the sale at wholesale of electric energy generated at the Bonneville project.

61. Sections 6 and 7, particularly the latter, are of paramount importance in connection with the matter of cost allocation, and for that reason these two sections have been quoted in full in paragraph 3 of this report. In Section 6, after making the Federal Power Commission responsible for the confirmation and approval of rate schedules prepared by the Administrator, the Congress added the following requirement: ". . rate schedules . . . shall be fixed and established with a view to encouraging the widest possible diversified use of electric energy" -- apparently the only limitation on the Bonneville service area being that the energy must be marketed "within economic transmission distance of the Bonneville project" (Section 4-d). The rates, based upon the allocation of costs which the Commission is to make, should be as low as practicable in order most fully to achieve this important objective.

62. Section 7 of the Act expresses the intent of the Congress that rate schedules shall be determined with due regard to and predicated upon the fact that the electric energy is generated as an incident to the construction of the Bonneville dam for the purposes set forth in Section 1 of the Act (see paragraph 54 above).

63. Section 11 of the Act authorizes the appropriation, out of moneys in the Treasury, of such sums as may be necessary for the "installation of equipment and machinery for the generation of electric energy and facilities for its transmission and sale".

64. It has been observed that it was the intent of the Congress that the rates charged for electric energy generated at the Bonneville

project should be as low as practicable. It is clear, however, that it was also the intent of the Congress that the rates be so fixed and established as to produce sufficient revenue to cover the cost of the energy delivered to markets within economic transmission distance; that is, the combined cost of production and transmission. The Act provides for the accomplishment of this purpose by requiring that "Rate schedules shall be drawn having regard to the recovery . . . of the cost of producing and transmitting such electric energy, including the amortization of the capital investment[1/] over a reasonable period of years"; and provides further that "Rate schedules shall be based upon an allocation of costs made by the Federal Power Commission" -- another mandatory provision. Then follows in the last sentence of Section 7 a permissive provision, which says that in computing the cost of the incidental byproduct electric energy, the Federal Power Commission may allocate to the cost of electric facilities such a share of the cost of facilities having joint value for the production of electric energy and other purposes as the power development may fairly bear as compared with such other purposes.

65. The schedules of rates and charges must of necessity be based upon the sum of the costs of the generating facilities and the transmission facilities, inasmuch as the rates must be designed to provide sufficient revenue to insure recovery of all costs in both of these

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1/ The combined capital investment in electric facilities for the generation and transmission of Bonneville energy, including such a share of the cost of joint-use facilities at the Bonneville project as the Commission may allocate to "electric facilities".

categories. The generation component of such aggregate costs will include such part of the cost of joint facilities at the Bonneville project as the Commission may allocate to "electric facilities".

66. Thus it is seen that the "allocation of costs" to power referred to in Section 7 of the Act will be comprised of three parts: (a) the entire cost of the power plant and such other costs at the Bonneville project as are chargeable directly and wholly to power development, including the cost of step-up transformers and other electrical equipment necessary for delivery of the power output to the Administrator; (b) such part of the cost of facilities at the Bonneville project having joint value for the production of electric energy and other purposes as the Commission may allocate to the costs of electric facilities; and (c) the entire cost of the Bonneville transmission system, thus far partially constructed by the Administrator and to be completed by him in accordance with the requirements of Section 2(b) of the Act.

Rate Schedules Now in Effect

67. Five schedules of rates and charges for the sale of power and energy produced at the Bonneville project, prepared by the Administrator and confirmed and approved by the Commission in accordance with the Act, are now in effect. They are designated as Schedules A-3, C-3, E-2, F-2, and H-2. An analysis of the BPA publication, "Sales of Electric Energy", showing data for the month of June 1944 and for the fiscal year 1944, indicates that if each customer had taken service

during the entire fiscal year under the schedule applying to the customer in June 1944[1/], the sales for that fiscal year, by rate schedules, and the approximate average revenue per kilowatt-hour for energy sold under each schedule, would have been as shown in the following tabulation:

Bonneville Rate Schedule	Bonneville-Grand Coulee Energy Sales (1,000 Kwh)	% of Total	Revenue (Dollars)	% of Total	Approximate Average Revenue (Mills per Kwh)
(1)	(2)	(3)	(4)	(5)	(6)
A-3	5,294.8	0.06	14,296	0.07	2.70
C-3	6,950,962.3	80.82	15,848,194	77.65	2.28
E-2	107,388.5	1.25	374,786	1.84	3.49
F-2	216,476.9	2.52	870,237	4.26	4.02
H-2	799,722.2	9.30	1,999,306	9.80	2.50
Subtotal	8,079,844.7	93.95	19,106,819	93.62	2.36
Exchange	520,609.7	6.05	1,301,524	6.38	2.50
Total[2/]	8,600,454.4	100.00	20,408,343	100.00	2.37

68. It will be observed from the above tabulation that about 81 percent of the Bonneville-Grand Coulee energy sales during the fiscal year 1944 were under rate schedule C-3, the kilowatt-year firm power schedule; and that 9.3 percent were under schedule H-2, the so-called "dump power" schedule. The average of 2.37 mills shown at the bottom of column (6) is about the same as the average revenue received per kilowatt-hour for all Bonneville-Grand Coulee energy sold during the fiscal year 1944, as reported by the Bonneville Power Administration.

1/ Data for month of May instead of June were used in a few cases.

2/ Data in this tabulation differ slightly from those reported by BPA on FPC Form No. 1, which shows energy sales of 8,671,091,375 kilowatt-hours in the fiscal year 1944.

69. The salient facts relating to each of the schedules of rates and charges now in effect are summarized below:

(a) Schedule A-3 applies to "at-site prime power", available to customers within 15 miles of the Bonneville power plant. The rate is $14.50 per year per kilowatt of billing demand, which, for high load factor power, is the lowest of the several rates. Customers taking service under this schedule must either consume it within 15 miles of the power plant, or if the energy is purchased for resale the principal part of it must be utilized within the area so defined. Thus far only two customers, both public agencies, have taken service under this schedule. Their power requirements are small.

(b) Schedule C-3 applies to prime power delivered from the Bonneville transmission system. The rate is $17.50 per year per kilowatt of billing demand. It is especially adapted to the requirements of customers who utilize power at high load factor, and for this reason the metallurgical and chemical industries and the large electric utilities take service under it. The average revenue per kilowatt-hour received for energy sold under this schedule during the fiscal year 1944 was less than that under any other schedule. Much the greater part of the power produced at the Bonneville project is now sold under Schedule C-3.

(c) Schedule E-2 is available only to customers who purchase power for resale to ultimate consumers, or to customers using power for irrigation pumping or drainage pumping. It applies to the sale of firm power either at site or from the transmission system. The schedule contains a two-part rate, the demand charge being 75 cents per month per kilowatt of billing demand, and the energy charge 2 mills per kilowatt-hour for the first 200 kilowatt-hours per kilowatt of billing demand, and 1 mill per kilowatt-hour for additional energy taken. This schedule is adapted to low load factor use. It contains a provision which limits the charge in any month, to public bodies and cooperatives, to not more than 3.5 mills per kilowatt-hour during a load development period. A purchaser must take at least 90 percent of his monthly energy requirements from the Bonneville Power Administration, or be billed on that basis, to qualify for this rate. This schedule also contains a special rate, demand charge of $4.50 per year per kilowatt of annual maximum demand, energy charge same as above, applicable to power sold for irrigation pumping or drainage pumping. At present most of the BPA sales to publicly owned distributors are under this rate.

(d) Schedule F-2 applies to the sale of prime power at site or at any point on the transmission system designated by the Administrator. This rate is adapted principally to the sale of power for stand-by purposes, and to the requirements of low load factor and medium load factor industrial and commercial customers. The demand charge is 75 cents per month per kilowatt of billing demand, and the energy charge is 2.5 mills per kilowatt-hour for the first 360 kilowatt-hours per kilowatt of monthly billing demand, and 1 mill per kilowatt-hour for additional energy. The features of this schedule relating to irrigation and drainage pumping are similar to those contained in Schedule E-2. Also there is a special rate of 5 mills per kilowatt-hour during a development period, applicable to sales to public bodies and cooperatives purchasing their entire power requirements from BPA. The provisions of Schedule E-2 are more liberal in this respect, however, and for this reason nearly all of the public agencies have shifted from Schedule F-2 to Schedule E-2.

(e) Schedule H-2 applies to the sale of "dump energy" to customers maintaining generating facilities adequate to their own needs or having firm contracts for stand-by power from other sources. "Dump energy" is defined as energy that may be generated from water that would otherwise be wasted. The points of delivery and the voltage at which the power is to be delivered are designated by the Administrator. The rate for "dump energy" is 2.5 mills per kilowatt-hour. This schedule also applies to emergency service, and is available to customers having their own generating facilities and rendering emergency service to BPA on a reciprocal basis.

Power Available at Bonneville Plant Bus
and Estimated Average Annual Deliveries to Customers

70. The operative date, name plate rating, and maximum capability of each of the main generating units, together with the rated plant capacity and maximum plant capability, are shown in the following tabulation:

Bonneville Power Installation

Unit No.	Operative Date	Name Plate Rating (kw)	Maximum Capability (kw)	Cumulative Maximum Capability (kw)
(1)	(2)	(3)	(4)	(5)
0	9-28-37	4,000 1/	-	-
2	6-6-38	43,200	55,000	55,000
1	7-18-38	43,200	55,000	110,000
4	12-23-40	54,000	59,000	169,000
3	1-9-41	54,000	59,000	228,000
5	9-5-41	54,000	59,000	287,000
6	5-18-42	54,000	59,000	346,000
7	3-31-43	54,000	59,000	405,000
8	6-15-43	54,000	59,000	464,000
9	9-15-43	54,000	59,000	523,000
10	12-14-43	54,000	59,000	582,000
Total - Units 1 to 10		518,400	582,000	582,000

1/ House unit.

71. The ten water wheels are alike in all respects but the generators of Units 3 to 10 have slightly greater over-all vertical dimensions than those of Units 1 and 2, and have greater capability, as shown by the above table. The tops of all of the generators were set at the same elevation, so that the difference in vertical dimensions would not mar the symmetry of the powerhouse interior. It will be observed that as indicated by the name plates, all of the units are underrated, Units 1 and 2 much more so than the others.

72. Assuming that the Bonneville and Grand Coulee projects will be operated in coordination both hydraulically and electrically in such manner as to obtain the maximum amount of prime power from the two

plants, and taking account of the effects of existing storage in the basin, the Bonneville Power Administration has estimated the Bonneville prime power at 403,000 kilowatts at the plant bus[1/]. This figure is based upon a regulated flow of 80,220 c.f.s.[2/], which could be maintained as an average at Bonneville over the five-month period, November to March, during a water year like the record low-flow year of 1936-37, and upon the assumptions that under such conditions the reservoir would be operated at elevation 80, and that 2,500 c.f.s. of the flow would not be used for power purposes[3/].

73. The BPA estimate of 403,000 kilowatts for the strictly continuous power, termed prime power, is regarded as somewhat too high under existing headwater storage conditions, but too low as an average over the 50-year amortization period. It is probable that during the first 10 years of the amortization period, sufficient additional headwater storage will be developed to raise the prime power above 403,000 kilowatts on a conservative basis of calculation, even assuming that the War Department will not approve of a maximum reservoir height in excess of elevation 78 during periods of extreme low flow approximating

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1/ The comparable BPA estimate of Grand Coulee prime power, after 15 main units shall have been installed in that plant, is 1,009,000 kilowatts.

2/ At times during the five-month low-flow period the power available at Bonneville might be less than 403,000 kilowatts, or that at Grand Coulee less than 1,009,000 kilowatts; also during rare periods of extreme high flow, that at Bonneville would be less than 403,000 kilowatts; but the BPA studies indicate that the two plants together would never have less than 1,412,000 kilowatts.

3/ The U. S. Engineer Department estimates water requirements for operation of the fishways and navigation lock, together with leakage and seepage losses, at 2,500 c.f.s.

the 1936-37 conditions[1]. It is concluded, therefore, that 403,000 kilowatts is a satisfactory figure for the prime power. Perhaps no better determination could be made at this time.

74. At present the power required for operating the navigation facilities and other project works, including electric service to shops and permanent buildings, and for lighting the premises amounts to about 1,700 kilowatts. This so-called "house load" may increase in the future, and with that contingency in view an allowance of 3,000 kilowatts is made for it. This leaves 400,000 kilowatts of prime power at the plant bus, for transmission to market.

75. The noncontinuous or secondary energy available at Bonneville before transmission, with normal operation of the reservoir at elevation 72, is estimated as follows: Secondary energy available 80 percent of the time, 600,000,000 kilowatt-hours per year[2]; remaining secondary energy, 353,000,000 kilowatt-hours per year; total, 953,000,000 kilowatt-hours per year.

76. A liberal allowance of 7 percent is made for power and energy losses between the plant bus and customers' meters[3], and it is estimated that as an average during the amortization period 90 percent of the prime power will be sold, at a load factor of 90 percent. Thus,

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1/ During the present war emergency the reservoir is being operated at elevation 78.

2/ It is expected that this better class of secondary energy will be utilized at a load factor of about 80 percent.

3/ The combined Bonneville-Grand Coulee system losses during the year ended September 30, 1944, were 6.6 percent. Bonneville losses should be somewhat less, as the generating plant is near the market.

the number of revenue-producing kilowatts of prime power is reckoned as 372,000[1/]. After study of the power situation in the Bonneville service area, present and prospective, both the Bonneville Power Administration and the staff of this Commission reached the conclusion that neither the sales factor nor the load factor would be less than 90 percent; and the Commission's staff believes that the two factors will be about the same, whether they approximate 90 percent or a higher figure. The load factor is more likely to decline than the sales factor, and if the former should be the lower of the two, the number of revenue-producing kilowatts would be increased.

77. With respect to the secondary energy, it is not possible to determine satisfactorily in advance either the marketable portion thereof or the amount of revenue to be derived therefrom. After giving full consideration to this matter, however, and obtaining the views of BPA, the Commission's staff is of the opinion that about five-eighths of the secondary energy, or say an average of 600,000,000 kilowatt-hours per year, will be delivered to and paid for by customers.

78. The commercial power and energy available at the generating plant for transmission to market, and the estimated revenue-producing units are summarized below:

1/ In case of a recurrence of the 1936-37 record low-flow conditions, both the sales factor and the load factor would probably be about 94 percent, with no appreciable change in the number of revenue-producing kilowatts.

Character of Power	Units Available at Plant Bus	Revenue Producing Units
(a) Prime Power.	400,000 Kw	372,000 Kw[1/]
(b) Prime Energy Equivalent. .	3,504,000,000 Kw-hrs	
(c) Secondary Energy Available 80% of the Time . .	600,000,000 Kw-hrs)	600,000,000 Kw-hrs
(d) Remaining Secondary Energy	353,000,000 Kw-hrs)	

1/ Firm power at 90 percent load factor (transmission losses, 7 percent; sales factor, 90 percent).

Theories of Joint Cost Allocations

79. Several methods or theories have been proposed by engineers and economists for allocating among purposes benefited, that part of the total cost of multiple-purpose water-control projects which has joint value for two or more purposes. In the final analysis, all of these theories stem from a concept of the sharing of benefits derived from joint endeavor or joint accomplishment.

80. Among the methods most discussed are the Benefits Theory, under which the joint costs are divided among the purposes on the basis of the estimated benefits derived from the joint venture; a variant of the benefits theory, known as the Alternative-Justifiable-Expenditure Theory, under which the joint costs are shared in proportion to the differences between the estimated alternative justifiable costs and the actual costs incurred specifically for each of the purposes; the

Use-of-Facilities Theory, in accordance with which the joint costs are divided on the basis of comparative use of the joint facilities; the Vendibility Theory, which requires no explanation here; the Specific-Costs Theory, by which the joint costs are simply divided in proportion to the specific costs incurred for each of the purposes; and the Equal-Apportionment Theory, under which the joint costs are divided equally among the principal purposes served.

81. In an abstract sense, there is merit to some of these theories, but generally they are not of considerable value in relation to water-control projects due to the infrequency of their applicability to practical situations. For instance, it is not difficult to appreciate the obstacles met in any effort to apply the use-of-facilities theory, the benefits theory, or the alternative-justifiable-expenditure theory to the Bonneville allocation problem, nor can any of the other theories be used advantageously.

82. At the request of the Commission, the U. S. Engineer Department prepared estimates of costs, including interest during construction at the rate of 2.5 percent per annum, of hypothetical single-purpose projects solely for power development and solely for navigation at the Bonneville site, with normal pool level at elevation 72[1/]. The alternative single-purpose power cost was estimated at $69,383,000, and that for navigation at $37,444,000, but the U. S. Engineer Department did not say these costs could be justified. That Department merely prepared the estimates as requested. However, this power-development

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1/ See Exhibit 5 for these and other alternative project estimates.

estimate supplies an acceptable figure for use in the alternative-justifiable expenditure theory, but the navigation-improvement estimate is regarded as too high to be of any value for that purpose; that is, the $37,444,000 would not be a justifiable expenditure.

83. A judgment figure could be adopted, of course, as representing the alternative justifiable expenditure for navigation, and used along with the $69,383,000 figure for power development in the application of the alternative-justifiable-expenditure theory. But it could hardly be said that the result would be superior to that obtainable by the application of informed judgment in the first instance.

84. It appears, however, that, ignoring the implications of Sections 1 and 7 of the Act, the application of any of these theories, except the equal-apportionment theory, would result in charging a preponderant share of the joint costs to power development; more, apparently, than was intended by the Congress.

Permissible Limits of Bonneville Joint Cost Allocation to Electric Facilities

85. In order to arrive at the aggregate capital cost, upon the basis of which schedules of rates and charges shall be established, it is necessary to determine the share of the cost of joint facilities at the Bonneville project that may fairly be borne by power, and add this amount to the sum of the specific power costs at the Bonneville project and the transmission costs. It is desirable first, however, as a preliminary to this determination, to consider the permissible limits of

the share of such joint costs that power might fairly bear under any circumstances -- the ceiling and the floor, so to speak -- in the light of the limitations which seem to be imposed by the Act. The Congressional intent, as clearly expressed in the Act or as reflected by reasonable interpretations of its pertinent provisions, should be observed.

86. Power development at the Bonneville project is incidental to the primary purpose -- navigation (Section 1 of the Act).

87. An important objective of the Act was and is "to encourage the widest possible use of all electric energy that can be generated" at the Bonneville project (Section 2-b); -- "rate schedules . . . shall be fixed and established with a view to encouraging the widest possible diversified use of electric energy" (Section 6). The Commission is jointly responsible for effecting compliance with the requirements of the latter directive.

88. "It is the intent of Congress that rate schedules for the sale of electric energy . . . generated at the Bonneville project . . . shall be determined with due regard to and predicated upon the fact that such electric energy is developed from water power created as an incident to the construction of the dam" as a navigation improvement (Section 7). Neither is this mandate directed to the Administrator alone. It is to be observed by any Governmental agency having any degree of control over the rates at which Bonneville power shall be sold, including, of course, the Federal Power Commission. The quoted language can hardly be construed as reflecting an intent that a major share of the joint costs should be allocated to electric facilities.

89. Attention is invited to the fact that the provision "Rate schedules shall be based upon an allocation of costs made by the Federal Power Commission" appears in Section 7 after the directive just referred to, and very significantly just before the following language: "In computing the cost of electric energy developed from water power created as an incident to and a byproduct of the construction of the Bonneville project, the Federal Power Commission may allocate to the costs of electric facilities such a share of the cost of facilities having joint value for the production of electric energy and other purposes as the power development may fairly bear as compared with such other purposes."

90. In the light of a careful study of the language of Sections 1, 2(b), 6, and particularly 7, it is concluded that Congress did not intend that a major share of the joint costs should be allocated to electric facilities.

91. It is necessary then that the Commission allocate to an incidental purpose — a subordinate purpose by the terms of the Act — some appropriate share of the joint costs. It appears that with only two important purposes served[1/] — one primary, the other subordinate — the share of the joint costs assignable to the primary purpose might approach 50 percent as a minimum limit; and the share allocable to the incidental or subordinate purpose might approach 50 percent as a maximum limit. Thus, in this case, 50 percent would be the practical maximum limit of the allocation to electric facilities.

1/ Unemployment relief is important, but as that "purpose" was served only temporarily, it is of a different category from navigation and power.

92. The language of the Act authorizing such an allocation is not mandatory, but permissive. If the Commission were convinced that power could not fairly bear any part of the joint costs, as the Commission found in the case of the Fort Peck project, presumably it would make no allocation at all. Hence, zero is the minimum limit.

93. It is concluded, therefore, that allocation to electric facilities of any share of the joint costs, between zero and 50 percent, is a matter within the discretion of the Commission. Within these limits the share so allocated will, of course, be that which, in the judgment of the Commission, power may fairly bear as compared with other purposes.

The Bonneville Rate Level

94. The Bonneville rate schedules now in effect have been made applicable also to the sale of power produced at the Grand Coulee project. More than half of the electric energy now being consumed in the five States of the Northwest -- Washington, Oregon, Idaho, Montana, and Utah -- is generated at the Bonneville and Grand Coulee projects[1/]. It may be said with substantial correctness, therefore, that the economy of that entire region is geared to the existing Bonneville rate structure; and for that reason it is assumed that so long as the Bonneville power output is not being sold below cost, no consideration whatsoever will be given to raising the rate level. For the information of the Commission, Bonneville power is not being sold below cost.

1/ Bonneville Power Administration press release No. N-815, of January 3, 1945.

Even if the Bonneville power system (meaning all facilities utilized for the generation and marketing of Bonneville energy) had been carrying 100 percent of the cost of joint facilities at the Bonneville project throughout the preamortization period ended June 30, 1944, the aggregate revenues properly assignable to Bonneville would have exceeded the corresponding aggregate expenses for said period by a margin of $913,000. Moreover, it appears from an inspection of revenue data and financial-requirements data for the nine months ended March 31, 1945, that the revenue for the current fiscal year will exceed the annual costs by a very substantial margin. Hence, it may be assumed that the established Bonneville rates will either remain unchanged or be lowered.

95. If the rates which shall be established on the basis of the allocation of costs to be made by the Commission should produce more revenue than is necessary to cover all annual costs by a reasonable margin, and if such rates should not be reduced, the capital investment in electric facilities would be recovered by the United States in a shorter period of time than 50 years.

Bonneville's Obligations with Respect to Justification of Economic Feasibility of Upstream Storage Projects

96. In considering the matter of an allocation of costs as a basis for establishing schedules of rates and charges, it appears that the Commission may properly take cognizance of Bonneville's obligations, present and future, in respect of justification of the economic

feasibility of Government water-control projects embodying headwater improvements, particularly storage reservoirs, beneficial to the Bonneville project. For instance, a very substantial part of the prime power now available at Bonneville is attributable to the better regulated flow of the Columbia River resulting from operation of the Grand Coulee reservoir, with its usable storage of 5,200,000 acre-feet.

97. It is expected that much additional storage will be provided in the Columbia River Basin above Bonneville at public expense, but considering the Bonneville plant as constructed, with its completed installation of ten main generating units (rated capacity 518,400 kilowatts; maximum capability 582,000 kilowatts), there is a definite limit to the volume of headwater storage that would be beneficial to it. There is a possibility that if some 15,000,000 acre-feet or more of additional headwater storage should be developed, radical changes in the Bonneville project, to increase the installation, would be warranted. The Commission would not be justified, however, in giving consideration at this time to the possibility of such a change being made in the distant future.

98. Nothing is said in the preceding paragraphs in contemplation of actual payments being made on behalf of the Bonneville project for benefits derived from headwater improvements at other Government projects. Obviously it would be a mistake, however, in considering the economic feasibility of a proposed Government reservoir on a headwater stream not to evaluate the benefits that would inure to downstream power developments as a result of the operation of the headwater storage.

Recent Report by Commissioner of Reclamation and Bonneville Power Administrator on Allocation and Repayment of Costs, Columbia Basin Project

99. One of the purposes of the Reclamation Project Act of August 4, 1939 (53 Stat. 1187), was "to protect the investment of the United States" in reclamation projects. Section 7(b) of that Act provides that "For any project . . . now under consideration or for which appropriations have been made, and in connection with which a repayment contract has not been executed, allocations of costs may be made in accordance with the provisions of section 9 of this Act . . ." Section 9(a) of that Act provides that "No expenditures for the construction of any new project, new division of a project, or new supplemental works on a project shall be made, nor shall estimates be submitted therefor, by the Secretary until after he has made an investigation thereof and has submitted to the President and to the Congress his report and findings on . . . the part of the estimated cost which can properly be allocated to power and probably be returned to the United States in net power revenues."

100. During the past year the Commissioner of Reclamation and the Bonneville Power Administrator prepared a "Joint Report on Allocation and Repayment of the Costs of the Columbia Basin Project", that project having been adjudged by them (after considering the Columbia Basin Project Act of 1943 -- 57 Stat. 14) to be within the scope of Section 7(b) of the Reclamation Project Act of 1939, permitting the making of allocations of cost under Section 9 of that Act. Their report and all the allocations, determinations, and findings set forth

therein were approved and adopted by the Secretary of the Interior on January 31, 1945. The following language, involving the Bonneville project, is quoted from Page 47 of the report:

> "The Bonneville Power Administration will pay to Grand Coulee out of revenues derived from the sale of power produced at Bonneville only for the benefits received from Grand Coulee storage. This payment is $187,570 per year for 50 years and represents 3% interest and amortization on $4,826,129, which is the portion of the commercial power allocation applicable to the Bonneville Dam Project."

101. Upon reading the Columbia Basin Project report referred to above, and having in mind the requirements of the Bonneville Act with respect to disposition of receipts, it was first understood that the Administrator did not in reality propose to make any actual payments to Grand Coulee, or rather to the Reclamation fund, out of Bonneville revenues on account of headwater benefits, but that he merely intended to take account of such amounts in the BPA bookkeeping, as an indication of Bonneville's contribution toward the economic justification of the Grand Coulee project. But in a letter dated May 5, 1945, to the Commission, commenting upon a draft of this report, the Administrator, upon the advice of counsel, says:

> "It is not the intention of the Columbia Basin Project report that such payments be entered only on the books of the Bonneville Power Administration. It is our understanding that revenues will be credited on the books of the Treasury to the Reclamation Fund instead of to Miscellaneous Receipts to the extent of the obligation for upstream river regulation."

102. In this connection attention is invited to the first sentence of Section 11 of the Bonneville Act (50 Stat. 731), which reads:

"Sec. 11. All receipts from transmission and sale of electric energy generated at the Bonneville project shall be covered into the Treasury of the United States to the credit of miscellaneous receipts, save and except that the Treasury shall set up and maintain from such receipts a continuing fund of $500,000, to the credit of the administrator and subject to check by him, to defray emergency expenses and to insure continuous operation."

103. There has been no occasion for this Commission to determine the headwater benefits to the Bonneville project attributable to the operation of the Grand Coulee reservoir. Section 10(f) of the Federal Power Act does not authorize such determinations by the Federal Power Commission where both the benefited project and the project having the headwater improvements are owned by the United States. Neither does the Federal Power Act nor any other statute, so far as is known to this office, authorize any other agency or department of the United States to make such determinations in contemplation of annual payments actually being made by or on behalf of the benefited project.

104. Bonneville benefits from Grand Coulee storage to a greater degree than would be the case if both Bonneville and Grand Coulee were privately owned and under Federal license, because according to the BPA commitment the two projects are and will continue to be operated in coordination in such manner that the prime power output from the two plants will be a maximum. In other words, the storage is operated for the mutual benefit of the two projects, which is obviously in the public interest. It is hardly probable that the operation of two privately owned water-power projects would be so well coordinated, particularly if the projects were owned by diverse interests, even though both were under Federal license.

105. Irrespective of what consideration, if any, the Commission may feel justified in giving to the proposed annual payment of $187,570[1/] per year during the 50-year amortization period as Bonneville's contribution to the economic justification of the Grand Coulee project, the Commission may assume with confidence that an actual payment in that amount, if such were permissible, would not be excessive.

106. It may be observed that while the Bonneville Act contains no language relating to headwater benefits, the Congress has, in the Federal Power Act, recognized the equity of payments for such benefits. In the instant case, the only question for consideration is whether the cost allocations and rates shall be determined and established with a view to having gross revenues sufficient in amount to cover all annual costs, and in addition provide a margin, of say about $400,000 per year, which when deposited in the Treasury to the credit of miscellaneous receipts as required by the Act, will in effect constitute a payment to the United States for benefits from headwater improvements, present and future.

What Share of the Joint Costs at the Bonneville Project May Navigation Fairly Bear?

107. Pursuant to a request of this Commission, the Chief of Engineers, War Department, caused a study to be made by the U. S. Engineer Department with a view to reaching a conclusion regarding the part of the Bonneville project cost which, in view of the superb improvement of

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1/ See somewhat larger figure at bottom of Page 33 of the Columbia Basin Project report.

the Bonneville-The Dalles stretch of river, could reasonably be charged to navigation. The views of the Chief of Engineers were desired for the information of the Commission in connection with its determination of the share of joint costs at the Bonneville project which may fairly be borne by power, in comparison with the share that may fairly be borne by other purposes. Attention is invited to the Deputy Chief of Engineers' letter of September 29, 1944[1/], in which he reports the results of that Department's studies, indicating that the present value of the direct benefits to navigation made possible by the Bonneville project is $13,170,000.

108. The Deputy Chief of Engineers calls attention, however, to indirect, intangible, and contingent benefits expected to result from this high-class navigation improvement, such benefits not being subject to appraisal on a firm statistical basis. He states that the estimate of $13,170,000 makes no allowance for the possibility that ocean-going vessels may use the deep-water channel above the Bonneville dam in the future, and refers to the national defense value of this navigation facility.

109. Taking into consideration benefits of the character referred to in paragraph 108 above, the Deputy Chief of Engineers informed the Commission of the view of the Office of the Chief of Engineers that an appropriate total allocation to navigation of Bonneville project costs would be the sum of the cost of the navigation facilities and one-half of the cost of the joint facilities.

1/ Exhibit 6 herewith.

110. The Corps of Engineers, U. S. Army, has been responsible for the planning, construction, operation, and maintenance of navigation facilities, and in general for improvement of the rivers of the United States for navigation, for more than a century. It is suggested that the views of that agency regarding justifiable expenditures for navigation improvements should enlist the attention of any tribunal dealing with a problem of that character. Its views, as set forth in the Deputy Chief of Engineers' letter, concerning the part of the Bonneville project costs that might reasonably be borne by navigation, are commended to the Commission for careful consideration in connection with its allocation of a fair share of the joint costs to electric facilities.

Potential Market for Secondary Energy Represented by a Class of Customers Who Cannot Afford to Take Service Under Any Rate Schedule Now in Effect

111. In the Bonneville service area there is a large potential market for secondary energy for the operation of electric boilers which might be installed by the pulp and paper industry if the rates charged for such energy were sufficiently low to meet the competition of "hogged fuel" or wood wastes, now used in such plants as fuel for producing steam. This situation has been investigated by the Bonneville Power Administration, and some study has been given to it by the Commission's staff. As yet the Administrator has submitted no new rate schedule for consideration by the Commission, and it is not known what he will propose. It appears, however, that the kilowatt-hour rate will

necessarily be low in comparison with the 2.5-mill "H-rate" charge (see paragraph 69), since otherwise the installation of electric boilers and the operation and maintenance of two complete sets of boilers would not be justified.

112. Several pulp and paper plants are located along or reasonably near the high-tension lines of the Bonneville transmission system, and their potential energy requirements are large enough to absorb all of the secondary energy available from the Bonneville project; however, only such part of the non-firm energy as would not be required by customers taking service under the existing H-rate would be available to this new class of customers.

113. In evaluating the Bonneville power output, all available secondary energy classified as marketable, except 80,000,000 kilowatt-hours per year assumed to be taken by H-rate customers, has been given a nominal value of one mill per kilowatt-hour. It will probably command a higher price.

Annual Financial Requirements

114. The annual financial requirements with respect to power facilities at the Bonneville project (including 50 percent of the joint costs) and the Bonneville transmission system, based upon completed facilities (that is, assuming that all costs chargeable to generation and transmission have been incurred), are considered in three categories, namely, fixed charges, operation and maintenance expenses, and interim replacements costs. The latter item is in the nature of

extraordinary maintenance, which, together with the usual maintenance, will keep all power facilities and joint facilities in first-class operating condition continuously during the 50-year amortization period[1/].

Bonneville Project Electric Facilities

115. Exhibit 7 shows, for power facilities at the Bonneville project, the estimated annual financial requirements in considerable detail, under the assumption that 50 percent of the cost of joint facilities will be allocated to electric facilities. This assumption is, of course, merely for illustrative purposes, and the statement may be adjusted readily in such manner as the Commission may desire to show comparable results for other allocations of joint costs. Fishways, being a joint responsibility, have been classified along with facilities having joint value for navigation and power development. The annual financial requirements, based upon a capital investment of $38,340,261 for specific power facilities, plus $20,368,047 as representing half the cost of joint facilities (total - $58,708,308), may be stated in brief form as follows:

1/ While it is possible, or perhaps probable, that Congress will enact legislation requiring that annual payments in lieu of State and local taxes be made on behalf of the Bonneville power system, and also that payments be made on account of headwater benefits, these elements of annual costs are not dealt with in the following statements because such payments are not now authorized or required. As indicated in paragraph 127 of this report, however, these items together might total about $750,000 per year.

Annual Financial Requirements
Power and Joint Facilities
at Bonneville Project

Fixed Charges (interest 2.5%; amortization 1.02581%)	$2,069,943
Operation and Maintenance (specific power facilities, $277,500; half of joint facilities, $122,500)	400,000[1]
Interim Replacements[2] (specific power facilities, $311,393; half of joint facilities, $31,421)	342,814
Total	$2,812,757
Annual financial requirements expressed as percent of capital cost	4.791

Bonneville Transmission System

116. At the request of the Chief Engineer, the Bonneville Power Administration, after estimating the capital cost of the Bonneville transmission system at $42,660,000, prepared an estimate of the annual financial requirements with respect thereto, which, as slightly modified to give effect to supplemental data supplied on March 12, 1945, by the BPA staff, is shown in brief form as follows[3]:

1/ The operation and maintenance costs were estimated by the U. S. Engineer Department at the request of the Commission. That Department built the Bonneville project and maintains and operates it (see Exhibit 10 herewith).

2/ Exhibit 9 shows estimate of interim replacements annuity in detail. The annual financial requirements for this purpose were determined by Senior Engineer Lesher S. Wing of the Commission's staff, in collaboration with representatives of the Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation.

3/ Exhibit 8 shows estimated annual financial requirements for Bonneville transmission system.

Annual Financial Requirements
$42,660,000 Bonneville Transmission System

Fixed Charges (interest 2.5%; amortization 1.02581%)	$1,504,111
Operation and Maintenance	1,156,796
Interim Replacements	707,729
Total	$3,368,636
Annual financial requirements expressed as percent of capital cost	7.897

117. As shown in the Transmission section of this report, the Commission's staff gave careful consideration to the BPA estimate of capital cost and concluded that it was moderately too high; and after mature consideration, it has been recommended that the Commission proceed under the assumption that the capital cost of the transmission lines and substations, and facilities and structures appurtenant thereto required by Section 2(b) of the Act, will be $40,000,000. About 70 percent of the cost of these facilities, collectively called the Bonneville transmission system, was incurred prior to July 1, 1944. The estimated financial requirements for the $40,000,000 system, prepared in exactly the same manner as was the BPA estimate, are shown below:

Annual Financial Requirements
$40,000,000 Bonneville Transmission System

Fixed Charges	$1,410,324
Operation and Maintenance	1,146,796
Interim Replacements	663,600
Total	$3,220,720
Annual financial requirements expressed as percent of capital cost	8.052

Combined Annual Financial Requirements

118. Combining the annual financial requirements of the Bonneville project and of the $40,000,000 Bonneville transmission system, the total is found to be as follows:

Annual Financial Requirements
Generation and Transmission

Electric facilities at Bonneville project	$ 2,812,757
Bonneville transmission system	3,220,720
Total	$ 6,033,477
Estimated ultimate capital cost	98,708,308
Total annual financial requirements expressed as percent of capital cost	6.1124

119. Thus it is seen that if the Federal investment in facilities for the generation, transmission, and sale of Bonneville power had been $98,708,308 as of July 1, 1944, the estimated average annual cost of the Bonneville power, delivered at the market (3,532,848,000 kilowatt-hours per year), during the 50-year amortization period would be $6,033,477, or 1.708 mills per kilowatt-hour.

Cost of Bonneville Energy
at the Market and at the Plant Bus

120. The actual situation as of July 1, 1944, was, however, as follows: Of the anticipated ultimate capital cost of $98,708,000, only about $86,128,000 had been expended ($57,803,000 for specific power facilities and joint facilities at the Bonneville project; and approximately $28,325,000 for transmission facilities and related general facilities). Capital costs remaining to be incurred amount to

about $12,580,000, of which $11,675,000 is for transmission facilities and $905,000[1/] for Bonneville project electric facilities. It is assumed that the remaining transmission costs will be incurred during the five fiscal years ending June 30, 1949, according to the program shown in paragraph 50.

121. Moreover, a calculation by the Commission's staff, based upon revenue data supplied by the Bonneville Power Administration, and expense data supplied by both the BPA and the U. S. Engineer Department, indicates that $4,528,000 of the aforementioned combined Federal investment in Bonneville generation and transmission facilities was recovered by the United States prior to July 1, 1944.

122. In view of the fact that $12,580,000 of the $98,708,000 estimated total capital cost has not as yet been incurred, and hence that part of the investment will necessarily be made some years subsequent to the focal date, July 1, 1944, and also of the fact that $4,528,000 of the Government's combined investment in electric facilities for the generation, transmission, and sale of Bonneville power was recovered by the Treasury during the development and equipment-installation period ended June 30, 1944, the aggregate annual costs will be less than the $6,033,477 shown in paragraph 119 above. Giving appropriate consideration to the time distribution of costs yet to be incurred, and to the calculated recovery of $4,528,000 of the Government's investment prior to July 1, 1944, and using an interest rate of

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1/ This figure is based upon the assumption that 50 percent of the cost of joint-use facilities at the Bonneville project will be allocated to electric facilities.

2.5 percent per annum, the Commission's staff has made a calculation which indicates the proper value of the estimated average annual costs during the 50-year amortization period to be $5,781,000.

123. The $5,781,000 shown at the end of paragraph 122 above is the estimated average annual cost at the market of Bonneville power deliveries to customers during the 50-year amortization period commenced July 1, 1944. Estimated annual energy deliveries, as computed from the revenue-producing units shown in paragraph 78, amount to 3,532,848,000 kilowatt-hours, the indicated average cost of which, at the market, is 1.636 mills per kilowatt-hour.

124. The corresponding estimated unit cost of the energy at the plant bus is 0.709 mill per kilowatt-hour.

Consideration of the Share of the Cost of Joint Facilities That Power May Fairly Bear

125. It has been concluded that, under what seems to be a proper interpretation of the Act, 50 percent of the cost of joint facilities at the Bonneville project is the maximum permissible limit of the contemplated allocation of such costs to electric facilities. If it should be found that power can readily bear -- and fairly bear -- 50 percent of the joint costs, as compared with what navigation and other purposes may fairly bear, it would appear to be in order to make the maximum permissible allocation to "electric facilities".

126. The question of what part of the Bonneville joint costs and of the total Bonneville project costs navigation may fairly bear has

Source: Allocation of Costs Bonneville Project

been touched upon in paragraphs 107 to 110, above, and the Commission's attention has been invited to the views of the Office of the Chief of Engineers, War Department, on this subject. That Office has expressed the opinion that an allocation of 50 percent of the joint costs to navigation would be appropriate.

127. On the basis of Bonneville rate schedules now in effect and of a 50-percent allocation of joint costs to electric facilities, and assuming the sale of 372,000 kilowatts of 90-percent-load-factor firm power at $17.50 per kilowatt-year; 80,000,000 kilowatt-hours of secondary energy at 2.5 mills per kilowatt-hour; and assigning a nominal value of one mill per kilowatt-hour to the remaining 520,000,000 kilowatt-hours of secondary energy, it is found that the annual gross revenues would exceed the aggregate annual financial requirements, including provision for amortization of the capital costs, by the margin of $1,449,000 per year. It is anticipated, however, that in addition to Bonneville's present and future obligations to contribute to the economic justification of headwater improvements beneficial to the Bonneville project, the Congress, in establishing a permanent administration, will provide for annual payments in lieu of State and local taxes; and if such payments should be on the same basis as those made by the Tennessee Valley Authority under the Act of Congress establishing that agency, this item and the headwater improvements obligation might together amount to about $750,000 per year. Thus, the indicated excess of annual revenue over annual costs would be reduced to about $700,000; and there would be no assurance that the margin would be this large, as that would

depend principally upon the degree of success the management might have in disposing of secondary energy.

128. The rates at which Bonneville power shall be sold will be based upon the Commission's allocation of costs, and if the Commission should allocate to "electric facilities" 50 percent of the joint-facilities costs at the Bonneville project it appears that, in view of the present and prospective financial obligations of the Bonneville power system, the rates now in effect could not be substantially lowered. It is desirable and necessary that the annual revenue exceed the annual costs by a reasonable margin.

129. It is concluded that power may fairly bear the maximum permissible share of the Bonneville project joint costs; that is, 50 percent of such costs.

Unemployment Relief

130. As stated in paragraph 12, the commencing of construction of the Bonneville project was occasioned by the Government's effort to provide work for unemployed people during a period of extreme business depression and widespread unemployment. Believing that the necessity for complying with the provisions of the National Industrial Recovery Act and the numerous rules and regulations thereunder resulted in some increase in the cost of the project, the Chief Engineer caused a study to be made of this matter in 1937. Notes prepared at that time have been reviewed recently, and a memorandum on the subject prepared in this office.

131. The officers and civilian engineers of the U. S. Engineer Department feel that the use of relief labor on the Bonneville project did not appreciably affect the costs, and express the opinion that even if the costs were increased, it would not be possible to determine the amount of the increase.

132. As a result of the study by the Commission's staff, however, it was concluded that conduct of the work for the relief of unemployment during the first three or four years of the construction period may possibly have increased the costs by as much as $3,000,000. However, it does not appear that any allocation to, or write-off on account of, unemployment relief would be desirable or justified, inasmuch as it would be difficult to substantiate any position that might be taken with respect to this matter.

Wartime Program for Expediting Installation of Bonneville Generating Equipment

133. In December 1941, immediately after the attack on Pearl Harbor, an expedited final-stage construction program was adopted by the War Department with a view to the installation of all remaining generating units in the Bonneville power plant as rapidly as possible. This action was taken as a wartime national defense measure.

134. Recognizing that this expedited program necessarily resulted in some increase in the cost of the Bonneville project, the Chief Engineer requested the U. S. Engineer Department to prepare an estimate of the amount of such increase. The estimate, prepared by the U. S. Engineer Office at Portland, Oregon, indicates an increase in cost

of $2,715,720[1/] reasonably attributable to the rush program. It would hardly be appropriate, however, to write off any part of the Bonneville project costs on this account, because the power load available to Bonneville due to the war increased as rapidly as generating facilities could be installed to serve it, with a resulting increase in revenue which much more than counterbalanced the aforementioned increase in project costs.

135. It may be of interest to the Commission to note from Exhibit 12 herewith that during the four fiscal years ended June 30, 1944, the Bonneville project generated 8,991,878,000 kilowatt-hours as compared with 9,317,182,000 kilowatt-hours generated at Grand Coulee, or 49.11 percent of the total. Grand Coulee commenced operation in March 1941.

Recommendations

136. Upon the assumption that in order to complete construction of all Bonneville electric facilities, and also the joint-use facilities at the Bonneville project, it will be necessary to incur additional capital costs as follows: For facilities at the Bonneville project having value solely for power purposes, $658,613 in addition to the $37,681,648 incurred therefor prior to July 1, 1944; for facilities at said project having joint value for the production of electric energy and other purposes, $492,368 in addition to the $40,243,726 incurred therefor prior to July 1, 1944; and for transmission lines and

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[1/] Exhibit 11 herewith.

substations, and facilities and structures appurtenant thereto required by Section 2(b) of the Act, $11,675,000 in addition to the $28,325,000 (approximately) incurred therefor prior to July 1, 1944;

It is recommended that:

(a) The Commission immediately allocate to electric facilities the following costs: The $37,681,648 expended prior to July 1, 1944, for facilities at the Bonneville project having value solely for power purposes; the sum of $20,121,800 of the $40,243,726 expended prior to July 1, 1944, for facilities at the Bonneville project having joint value for production of electric energy and other purposes; and the $28,324,922 expended prior to July 1, 1944, for transmission lines and substations, and facilities and structures appurtenant thereto, pursuant to the provisions of Section 2(b) of the Act; making a total immediate allocation of costs to electric facilities in the amount of $86,128,370.

(b) The allocation of costs to electric facilities recommended in paragraph (a) above ($86,128,370), and each of the three component parts thereof, be made subject to future revision and readjustment by the Commission in order that the Commission may duly consider and make appropriate disposition of such capital costs as may be reported to it by the Corps of Engineers and the Bonneville Power Administration in addition to the costs already reported by those agencies.

Roger B. McWhorter
Chief Engineer.

Washington, D. C.
June 15, 1945.

C O P Y

Table #1 ep

BONNEVILLE DAM MARKET AREA

ESTIMATED PEAK LOAD - POSTWAR BASIS

		Kilowatts 1944	1945	1946
Public Agencies, Including Dump /1		16,620	22,650	25,300
Industries:				
Alcoa	175,000			
Vancouver Shipyards	12,000			
Electro-Metallurgical	13,000			
Pennsylvania Salt	2,400			
Pacific Carbide	2,000			
Columbia Metals Corp.	12,000			
Total Industries		216,400	216,400	216,400
Non-Federal Utilities				
P.P. & L. Co. (Astoria)		2,350	2,720	3,100
Copco & Mt. States		21,000	22,100	23,150
P.G.E. & N. E. Co.		94,100 /2	109,400	126,400
Total		350,470	373,270	394,350
Transmission Losses 7%		24,530	26,130	27,600
Total Peak Load		375,000	399,400	421,950
Dump Power to Utilities		70,000	110,000	110,000
Transmission Loss 7%		4,900	7,700	7,700
Total		449,900	517,000	539,650

/1 The load of the Administration's present and prospective public agency customers is included.

/2 Based upon 1941 load with normal growth.

System Development Section
7-19-44

C O P Y

Table #2-Sheet #1

ANALYSIS OF BPA CAPITAL INVESTMENT IN TRANSMISSION FACILITIES 230 KV LINES & SUBSTATIONS

W. O.	Facilities	Estimated Cost	
	Bradford Island Crossings 1 & 2	$ 198,117	
5	Bonneville-Vancouver 230 #1 and 2	1,961,462	1/
7	North Bonneville Substation	725,380	
8	J. D. Ross Substation	2,137,370	
83	J. D. Ross Substation 2nd Transformer	966,090	
120	Control Line No. Bonneville	53,600	
158	N. Bonneville Substation and Additions	540,000	
159	J. D. Ross Substation 1942 Additions	1,395,100	
199	Bradford Island Crossing Fences	1,830	
206	Communication Cable N. Bonneville-Power House	6,110	
7036	Line Shifts for Bonneville-Vancouver #1	3,010	
322	Shifting Crossings at Bonneville	13,610	
432	J. D. Ross Substation, Carrier Comm. Channel #2	26,590	
482	Permanent Airway Lighting Installation Bradford Island 1 & 4	1,645	
504	Telemetering Installation J. D. Ross	32,700	
503	Telemetering Equipment No. Bonneville Substation	1,000	
493	Line Relays for 230 kv O.C.B. A 27 J.D. Ross	2,000	
524	J. D. Ross Sub-Condenser No. 3 Water Intake Pipe	2,790	
	Sub-total	$8,068,404	
15	½ Cost Bonneville-Midway 230 kv line #1	1,321,926	1/
141	½ Cost Bonneville-Midway 230 kv line #2	1,758,899	1/
27	Vancouver-Kelso 230 kv line	1,702,731	1/
	Total	$12,851,960	

1/ Includes WPA contribution for clearing right-of-way.

System Development Section
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ANALYSIS OF BPA CAPITAL INVESTMENT IN TRANSMISSION FACILITIES

115 KV Lines & Substations

W. O.	Facilities	Estimated Cost
197	Crossing Tower Fences - Columbia River	$ 10,280
71	Alcoa Service Connection	630,000
20	Vancouver-St. Johns 115 kv 1 & 2	400,000
147	Alcoa Substation 1942 Additions	1,009,000
148	Vancouver-Alcoa 115 kv line #3 & #4	181,000
265	Service to Vancouver Shipyard	78,890
267	Vancouver Shipyard Substation	173,600
268	J. D. Ross Additions for Vancouver Shipyards	90,100
296	Mill Plain Substation	93,380
323	Temporary Metering Kaiser Apts.	1,640
324	Temporary Metering Vancouver Dormitories	1,640
325	Temporary Metering Air Reduction Inc.	1,100
84	Bonneville-Oregon City Lines 1 & 2	2,487,291 1/
112	St. Johns-Oregon City-Salem	563,670
20	St. Johns-Eugene Line #1	1,253,500
64	St. Johns-Astoria 115 kv line	1,179,040
21&113	St. Johns Substation	1,427,970
22&149	Oregon City Substation	409,095
23	Salem Substation	951,320
24&274	Albany Substation	66,931
25	Eugene Substation	198,230
53	Astoria Substation	234,540
198	Crossing Tower Fences	4,290
35	Bonneville-The Dalles 115 kv line	1,093,782 1/
37	The Dalles Substation	41,500
122	Benton Lincoln REA Interconnection	61,800
207	Service to Electro-Metallurgical Co.	9,470
455	Installation Static Capacitors Alcoa Substation	416,950
165	Bonneville-Vancouver 5 & 6	1,711,900
99	Bradford Island Crossing No. 3	99,600
293	Shifting Poles at St. Johns Substation	2,410
288	Eugene Substation Carrier Current Equip.	1,760
387	Installation Condenser Neutral Resistor-Salem Substation	1,340
401	Vancouver Shipyard Substation Additions - Clark Co. PUD	15,090
412	Access Road in vicinity Salem Substation	2,930
438	Installation Oil Purifying Equipment Salem Substation	5,030
416	St. Johns Substation - Transformer Cooling Installation	14,000
466	Remote Control of Airway Lighting-Willamette Crossing #1	1,460
397	West Portland Substation - Land	10,615
482	Willamette R. Crossing Protection Str. #66/8	2,810
486	Relays, Bonneville-Ross Alcoa No. 5	5,400
521	Vancouver Shipyard Additions	13,500
7132	Relocate Guys Str. 66/7 Vancouver Eugene line	550
522	Permanent Retaining Walls & Drains Salem Sub.	24,800

489	Santiam River Crossing Mile 79 Vancouver-Eugene Line	$ 19,755
548	Spare 12,500 kva transformer for St. Johns Substation	31,500
568	Tap to West Portland Substation - Vancouver-Ore. City 1&2	89,280
173	Rainier-Longview 115 kv line #1 Cir. #1 & #2	444,880
269	Astoria Radio Station & Carrier Current Equip.	27,750
271	Albany Substation Carrier Current Equip.	12,190
352	Alterations Willamette River Crossing	2,870
	Sub-total	$15,611,429

Proposed Additional 115 kv Facilities

Albany-Toledo	$650,000	
Salem-Albany #2	234,000	
Albany-Eugene #2	328,000	
Eugene-Springfield	110,000	
Salem-Columbia Metals	51,850	
Willamette River Crossing near Linton	100,000	
Westport Substation	65,000	
Alcoa Substation	350,000	
St. Johns Substation	1,000,000	
Hood River	65,000	
Oregon City	750,000	
Salem	180,000	
Albany	175,000	
Eugene	225,000	
Toledo	100,000	
Columbia Metals	100,000	
TOTAL		$ 20,095,279

1/ Includes WPA Clearing

System Development Section
7-19-44

ANALYSIS OF BPA CAPITAL INVESTMENT

IN TRANSMISSION FACILITIES

Subtransmission Facilities

W. O.	Facilities	Estimated Cost
67	Klickitat County Extensions	$ 78,400
181	Metering Ore. 5 Clatsop	770
7035	Transformer Coast Guard - Astoria	250
65 &103	Forest Grove Substation	12,875
77	Salem-McMinnville Line	142,870
78	McMinnville Substation	38,200
166	Service to Tongue Point	146,280
179	Service to West Salem Cooperative	4,930
184	Service to Salem Electric Cooperative	9,320
203	Purchase of Salem Electric Co-op Lines	8,670
262	Salem Electric Co-op Metering	3,070
116	Monmouth Service	63,880
12	Bonneville Cascade Locks Line	15,818
13	South Bank Substation	63,495
62	Fuses for Cascade Locks Line	168
63	Underground Feeders S. Bonneville	14,318
234	Willamina Grand Ronde 57 Kv Line	87,450
235	Boyer-Tillamook 57 kv line	519,970
239	Purchase & Rehabilitation Grand Ronde-Boyer Line	23,650
241	Tillamook Substation	49,000
242	Switching & Metering Boyer Substation	10,400
327	Rehabilitation Salem-Monmouth Line	6,550
358	Willamina Switching Station	25,800
19	Northwestern Electric Co. Tie Lines	5,054
372	Bonneville-Cascade Locks Line-Survey & Mapping	2,750
335	Tillamook Naval Air Station Substation	74,880
242	Installation Metering Equipment Boyer Substation	3,310
549	Spare Transformer Forest Grove Substation	6,300
	Sub-Total	$1,418,428

Proposed Subtransmission System Additions

St. Johns-Forest Grove Line and Substations at Forest Grove	280,000
The Dalles-Moro	354,000
Klickitat Co. PUD	80,500
Pacific Carbide & Alloys	26,500
City of Canby	156,000
Forest Grove-Vernonia Line & Substation at Vernonia	250,000
Salem-Willamina 57 kv line	145,000
Eugene-Drain Line	168,810
Drain Substation	12,420
Total	$2,891,658

System Development Section
7-19-44

C O P Y

Table #2-Sheet #5
ep

ANALYSIS OF BPA CAPITAL INVESTMENT

IN TRANSMISSION FACILITIES

Buildings & Improvements

W. O.	Facilities	Estimated Cost
38	J. D. Ross Sub.-Warehouse & Shop	$466,660
40	Alterations Adcox Building	1,794
41	Alterations 811 N.E. Oregon	990
186	District Office Bldg. - J. D. Ross	78,800
218	J. D. Ross Paint & Oil Building	96,680
219	J. D. Ross Bulk Storage Area	38,200
223	J. D. Ross District Office Building #2	79,230
247	J. D. Ross Warehouse #2	1,520
253	J. D. Ross Site & Utility Development	114,140
7032	J. D. Ross Cafeteria Equipment	3,000
249	J. D. Ross Carpenter Shop (Temporary)	12,430
266	U. S. Forest Service Telephone Facilities	19,300
	Sub-total	$912,744

Proposed Substation Site & Building Improvements *

Albany	$ 35,100
Alcoa	38,500
Astoria	39,000
Eugene	20,400
Hood River	66,900
McMinnville	6,300
N. Bonneville	62,800
Oregon City	37,200
Salem	54,400
St. Johns	70,700
The Dalles	15,300
J. D. Ross - ½ of New General Buildings	1,445,000
Total	$2,804,344

* Substation improvements deferred by material shortage.

System Development Section
7-19-44

C O P Y

Table #3 ep

BONNEVILLE DAM MARKET AREA

ANALYSIS OF BPA CAPITAL INVESTMENT

FOR TRANSMISSION OF POWER

FROM BONNEVILLE DAM

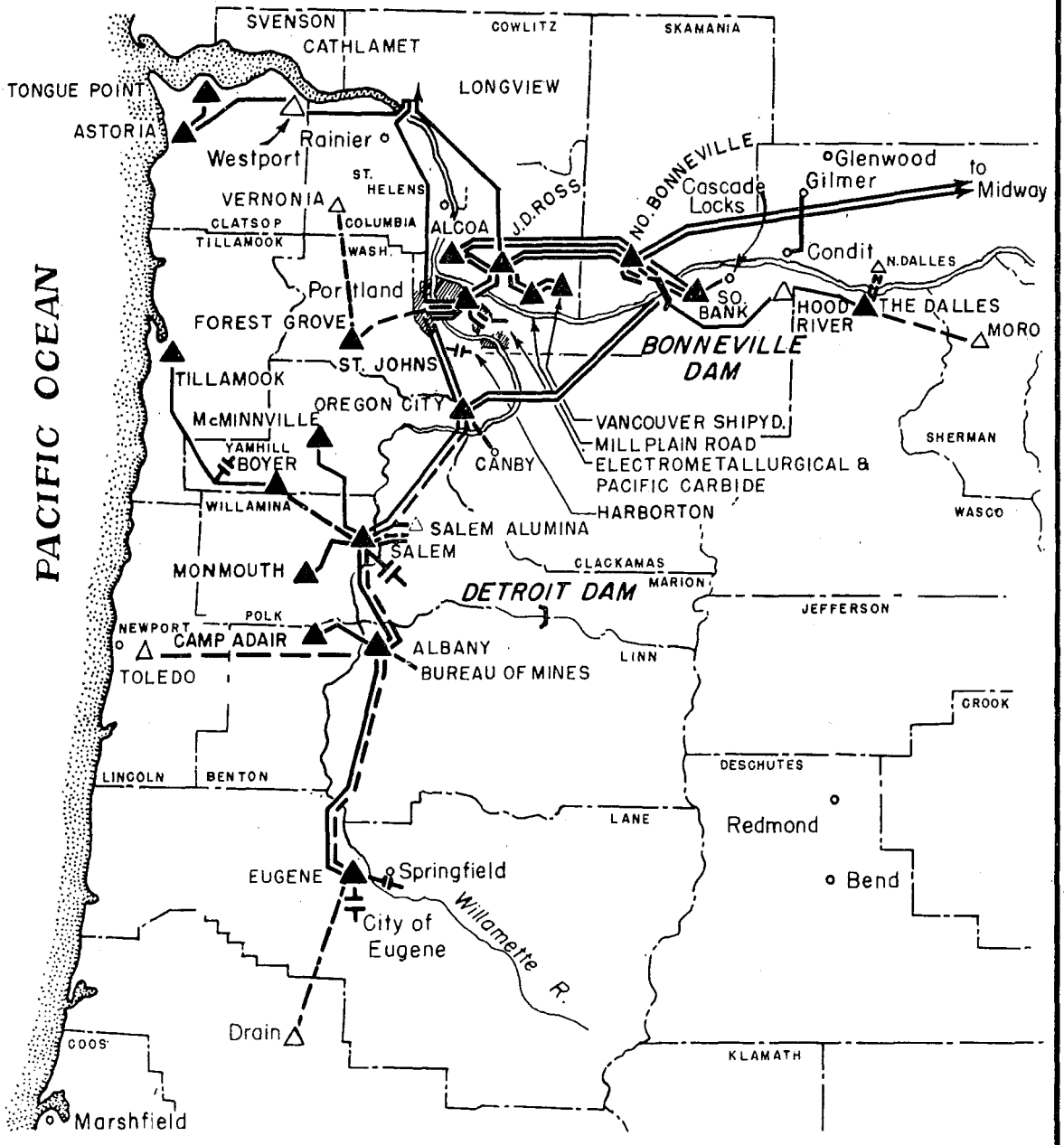
SUMMARY

Total Investment in Transmission and General Facilities

1.	230 kv lines and substations	$12,851,960
2.	115 kv lines and substations	20,095,279
3.	Subtransmission	2,891,658
4.	Miscellaneous customers' connections	1,250,000
5.	Sub-total	$37,088,897
6.	Substation, site and building improvements	2,804,344
7.	¼ Estimated cost proposed Administration Bldg.	912,500
8.	Other capital investments (5% of Item 5)	1,854,445
9.	Total	$42,660,186

System Development Section
7-19-44

TRANSMISSION SYSTEM FOR MARKETING POWER FROM BONNEVILLE DAM



LEGEND

- Transmission Lines
- Substations
- Proposed Construction
- Interconnection

BONNEVILLE POWER ADMINISTRATION
SYSTEM DEVELOPMENT SECTION
MAY 13, 1944

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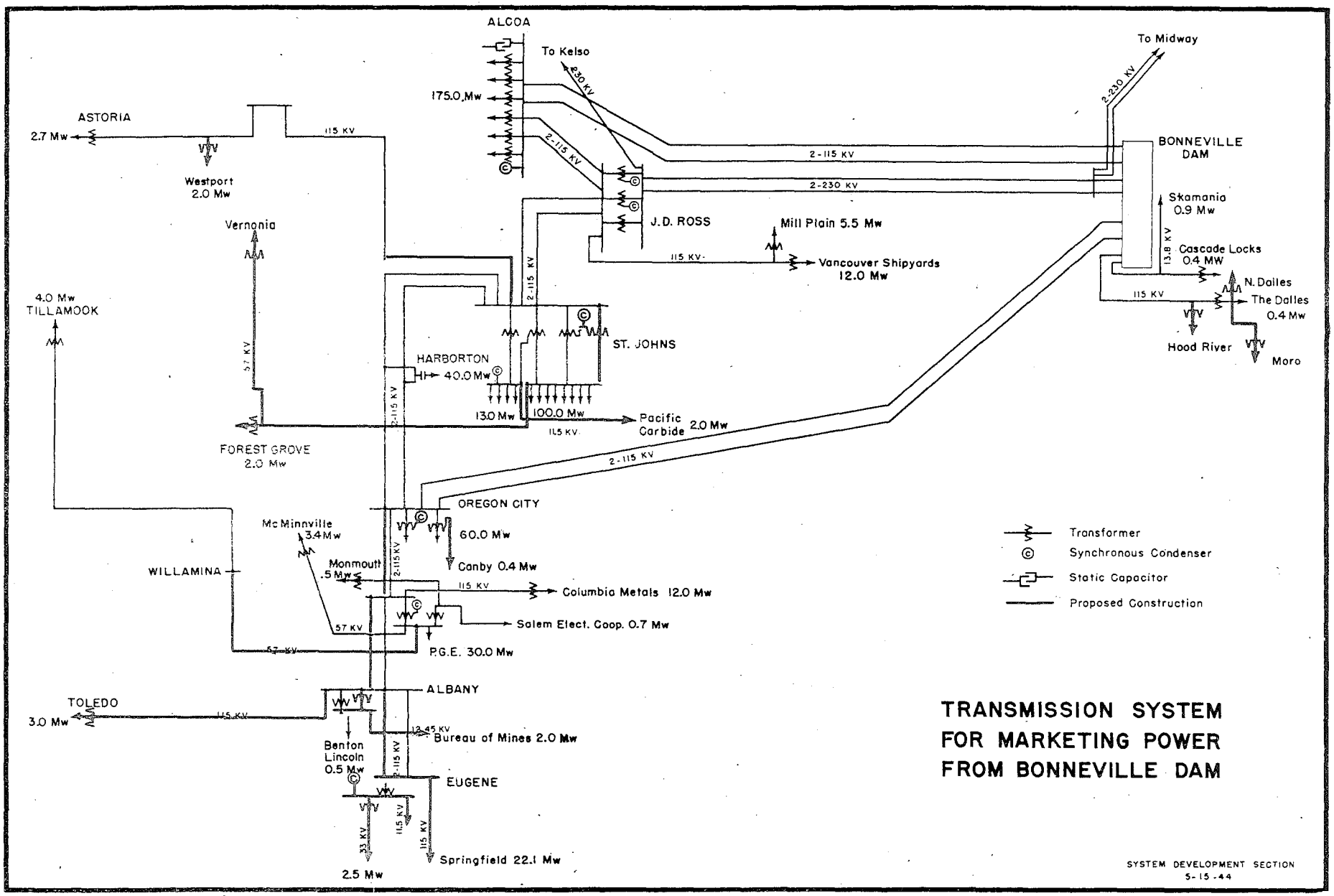
ALCOA
To Kelso
230 KV
175.0 Mw
2-115 KV
To Midway
2-230 KV
BONNEVILLE DAM
2-115 KV
2-230 KV
Skamania 0.9 Mw
13.8 KV
Cascade Locks 0.4 MW
N. Dalles
The Dalles 0.4 Mw
Hood River
Moro
J.D. ROSS
Mill Plain 5.5 Mw
115 KV
Vancouver Shipyards 12.0 Mw
ASTORIA
2.7 Mw
115 KV
Westport 2.0 Mw
Vernonia
4.0 Mw TILLAMOOK
57 KV
2-115 KV
ST. JOHNS
HARBORTON
40.0 Mw
130 Mw
100.0 Mw
115 KV
Pacific Carbide 2.0 Mw
FOREST GROVE 2.0 Mw
2-115 KV
OREGON CITY
McMinnville 3.4 Mw
60.0 Mw
Canby 0.4 Mw
WILLAMINA
Monmouth .5 Mw
115 KV
Columbia Metals 12.0 Mw
57 KV
Salem Elect. Coop. 0.7 Mw
57 KV
P.G.E. 30.0 Mw
ALBANY
TOLEDO
3.0 Mw
115 KV
13.45 KV
Bureau of Mines 2.0 Mw
Benton Lincoln 0.5 Mw
2-115 KV
EUGENE
33 KV
11.5 KV
115 KV
Springfield 22.1 Mw
2.5 Mw
Transformer
Synchronous Condenser
Static Capacitor
Proposed Construction
TRANSMISSION SYSTEM FOR MARKETING POWER FROM BONNEVILLE DAM
SYSTEM DEVELOPMENT SECTION
5-15-44

EXHIBIT 5
(2 Sheets)

C O P Y

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

Refer to File No. CE
SPEWR

19 December 1944

Mr. Roger B. McWhorter, Chief Engineer,
Federal Power Commission,
1217 Hurley-Wright Building,
1800 Pennsylvania Avenue, N.W.,
Washington, D. C.

Dear Mr. McWhorter:

I am pleased to summarize below the cost estimates for the various alternate schemes of improvement at Bonneville which have been the subject of your recent telephone calls:

Improvement	Estimated First Cost Without Interest During Construction	Estimated First Cost With Interest During Construction	Estimated Normal Annual Cost For Operation and Maintenance
For Bonneville project, normal pool elevation 72, if constructed solely for power development with no cost for fishways or navigation facilities.	$64,590,000	$69,383,000(1)	$482,500
For Bonneville project, normal pool elevation 72, if constructed solely for navigation (24 ft. channel depth) with no cost for fishways or power facilities.	35,661,000	37.444,000(2)	242,500
For Bonneville proje. constructed for pool elevation 56 solely for navigation (12 ft. channel depth) with no cost for fishways or power facilities.	28,570,000	30,000,000(2)	190,000

EXHIBIT 5
(2 Sheets)

C O P Y

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OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

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Improvement	Estimated First Cost Without Interest During Construction	Estimated First Cost With Interest During Construction	Estimated Normal Annual Cost For Operation and Maintenance
For side canal and locks between Warrendale and pool above Cascade Rapids solely for navigation (12 ft. channel).	$23,150,000	$24,300,000(2)	$120,000

(1) Interest at 2-1/2 per cent for one-half of construction period of 6 years for dam and reservoir and 2 years for buildings and grounds.

(2) Interest at 2-1/2 per cent for one-half of construction period of 4 years.

All of the foregoing costs are on the 1934-35 level. The above annual costs include no provision for such interim replacements as might be necessary during the amortization period.

For the Chief of Engineers:

Very respectfully,

/s/ Geo. R. Goethals

GEO. R. GOETHALS,
Colonel, Corps of Engineers,
Chief, Civil Works Division.

EXHIBIT 6
(3 Sheets)

C O P Y

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

Refer to File No. CE
SPEWR

29 September 1944

Honorable Leland Olds, Chairman,
Federal Power Commission,
Washington (25), D. C.

Dear Mr. Chairman:

This office has now completed its review of field reports on "an estimate of the alternative justifiable expenditure for navigation improvements in the stretch of the Columbia River covered by the Bonneville dam and reservoir," requested in letters from the Commission dated 16 February 1944 and 25 August 1944, and referred to in letters of this office dated 6 April 1944 and 29 August 1944.

As you know, the term "alternative justifiable expenditure" has come to be applied to a specific theory of cost allocation for multiple-purpose projects. In my opinion, this theory is not applicable to the Bonneville project, because the potential benefits would not have justified the cost of facilities, solely for navigation, equivalent to those made available by the existing multiple-purpose development. However, the following is presented for your information and consideration.

Assuming completion of improvements on the Columbia and Snake Rivers to Lewiston, Idaho, the District Engineer now estimates that at the end of 50 years the traffic through the Bonneville pool will be 3,300,000 tons annually. Since approximately 700,000 tons annually are now using the pool, it may be assumed that the average traffic, over the 50-year period, will be 2,000,000 tons annually.

Transportation savings attributable to the Bonneville project, estimated on the basis of the difference between cost to carriers for hauling the predicted average annual traffic in equipment that could be used if the river were improved by open-channel work, and the cost to carriers in equipment adapted to the present channel, are computed to be $0.32 per ton. The average annual transportation saving attributable to the project is therefore $640,000 a year. Deducting the annual costs of operation and maintenance assignable to navigation, estimated

at $175,000, leaves a net annual saving of $465,000. This saving, capitalized at 3.53 per cent (2-1/2 per cent interest as used by the Commission and amortization in 50 years) amounts to approximately $13,170,000 as the indicated present value of the direct benefits to navigation made possible by the Bonneville development.

The traffic prediction used in this estimate conforms with the suggestion made in your letter of 25 August 1944, that future traffic may be three times as great as that now using the waterway. The average annual traffic for the 5-year period ended 30 June 1943 was 683,339 tons. Three times this figure gives 2,050,000 tons as the indicated annual traffic through the Bonneville pool, as compared with 2,000,000 tons used in the foregoing estimate.

There are also indirect and contingent benefits which cannot be appraised on any firm statistical basis. They are here enumerated for the information of the Commission:

1. The estimated traffic of 2,000,000 tons annually is based on the assumption that additional improvements will be made upstream from Bonneville. The cost of the remaining dams, the order in which they are built, and the time at which all contemplated improvements are completed, will affect the accuracy of the findings as to net benefits. Given certain favorable assumptions as to this future development, there is reason to believe that somewhat higher benefits might be attributed to the Bonneville project.

2. The foregoing estimate of $13,170,000 makes no allowance for the possibility that ocean-going vessels may use the Bonneville pool at some future time.

3. National defense value.

4. The project will doubtless be used extensively for recreational boating.

5. Finally, there are always certain intangibles the Engineer Department usually does not attempt to evaluate in connection with any waterway project. These include the contribution of public works construction to economic stabilization and growth and the effect of waterways in enhancing the values of land and other capital goods in the areas served.

Summarizing, the indicated present value of the direct navigation benefits that will be produced by the Bonneville project, on the assumptions stated, is $13,170,000. There are also intangible and contingent benefits which cannot be accurately appraised on a money basis but they are nevertheless real and important.

Taking into consideration the direct and intangible benefits it is the view of this office that an appropriate allocation of costs to navigation would be an amount represented by the sum of the cost of navigation facilities plus one-half of the cost of the joint facilities. On the basis of the total cost of the facilities furnished by this office in letter dated 5 April 1944 amounting to $81,386,229.33 the allocation to navigation would accordingly be $24,904,000 in round figures.

Sincerely yours,

/s/ Thomas M. Robins

THOMAS M. ROBINS,
Major General,
Deputy Chief of Engineers.

EXHIBIT 7
(1 Sheet)

ANNUAL COSTS, BONNEVILLE PROJECT

Based on Specific Power Costs of $38,340,261, plus half of Joint Costs, $20,368,047; Total $58,708,308.

A.	Fixed Charges			
	1. Specific Power Facilities			
	a. Interest at 2.5%	$958,507		
	b. Amortization at 1.02581%	393,298		
	c. Total, Specific Power Facilities		$1,351,805	
	2. Half of Joint Facilities			
	a. Interest at 2.5%	509,201		
	b. Amortization at 1.02581%	208,937		
	c. Total, Half of Joint Facilities		718,138	
	3. Total, Fixed Charges			$2,069,943
	4. Total, Fixed Charges in % of Capital Investment			3.526
B.	Operation and Maintenance			
	1. Specific Power Facilities		277,500	
	2. Half of Joint Facilities		122,500	
	3. Total, Operation and Maintenance			400,000
	4. Total, O. & M. in % of Capital Investment			0.681
C.	Interim Replacements			
	1. Specific Power Facilities		311,393	
	2. Half of Joint Facilities		31,421	
	3. Total, Interim Replacements			342,814
	4. Total, Interim Replacements in % of Capital Investment			0.584
D.	Total Annual Costs			
	1. Specific Power Facilities		1,940,698	
	2. Half of Joint Facilities		872,059	
	3. Total, Annual Costs			$2,812,757
	4. Total, Annual Costs in % of Capital Investment			4.791

EXHIBIT 8
(1 Sheet)

ANNUAL COSTS, BONNEVILLE TRANSMISSION SYSTEM[1]

Bonneville Transmission Capital	Case I $42,660,000	Case II $40,000,000
A. Fixed Charges		
1. Interest at 2.5%	$1,066,500	$1,000,000
2. Amortization at 1.02581%	437,611	410,324
3. Total Fixed Charges	$1,504,111	$1,410,324
4. Fixed Charges in % of Capital Investment	3.526	3.526
B. Operation and Maintenance		
1. Transmission Expense		
a. Substations[2]	$ 433,210	$ 433,210
b. Transmission Lines	180,227	170,227[3]
c. Distribution	6,367	6,367
d. Total Transmission Expense	$ 619,804	$ 609,804
2. Administrative and General	426,011	426,011
3. Sales Promotion	53,333	53,333
4. Customers' Accounting & Collections	23,648	23,648
5. Guards	34,000	34,000
6. Total Operation and Maintenance	$1,156,796	$1,146,796
7. Total O. & M., in % of Capital Investment	2.712	2.867
C. Interim Replacements		
1. Total, at 1.659%	$ 707,729	$ 663,600
2. Interim Replacements in % of Capital Investment	1.659	1.659
D. Total Annual Costs		
1. Total Annual Costs	$3,368,636	$3,220,720
2. Total Annual Costs in % of Capital Investment	7.897	8.052

1/ Restatement of Table I, BPA Statement 19 (transmitted with Administrator's letter of December 9, 1944), showing annual costs, Bonneville transmission system, for capital investment of $42,660,000 (Case I), according to BPA suggestion; also annual costs for capital investment of $40,000,000 (Case II), as prepared in like manner by Commission's staff.

2/ No reduction in substation expense is assumed to result from elimination of cost of one switching position at North Bonneville switching station, and of one switching position at J. D. Ross substation.

3/ Transmission line expense was corrected for elimination of costs of 230-kv lines as follows: Half of Vancouver-Kelso line (22 mi.), and half of one Bonneville-Vancouver line (18 mi.). Reduction in transmission line O. & M. expense reckoned as $250 per mile; amount $10,000.

EXHIBIT 9
(20 Sheets)

FEDERAL POWER COMMISSION
SAN FRANCISCO REGIONAL OFFICE

December 12, 1944.

To: The Chief Engineer
Federal Power Commission
Washington, D. C.
(Through: Regional Administrator, San Francisco, California.)

Subject: Cost of Interim Replacements, Power Facilities and Joint Facilities - Bonneville Dam Project.

Authority, Purpose, and Scope.

1. This memorandum deals with the estimated cost of replacements, as necessary, of power facilities and joint facilities at the Bonneville Dam Project during the 50-year amortization period commenced July 1, 1944. It has been prepared as directed by Roger B. McWhorter, Chief Engineer, for use in connection with the allocation to power development of a part of the costs of the Bonneville Dam Project. The estimates of interim replacements presented herein conform to the following instructions:

(a) Based on a detailed analysis of depreciable items and on estimated service lives thereof, determine the average annual cost, during the amortization period, of the replacements of power and joint facilities not includible in routine maintenance.

(b) Assume the capital investment in power facilities and joint facilities to be amortized during a 50-year period, beginning July 1, 1944.

(c) Use an interest rate of 2½ percent per annum.

(d) Assume the cost of each new replacement to be the same as the cost of the item replaced.

2. The Bonneville Act approved August 20, 1937 (50 Stat. 731) states: "Rate schedules shall be drawn having regard to the recovery * * * of the cost of producing and transmitting such electric energy, including the amortization of the capital investment over a reasonable period of years." The annual costs to be recouped in rates during the amortization period are comprised of (a) interest, 2.5 percent, (b) amortization, 1.025806 percent, (c) operation and maintenance expense, (d) general expense, and (e) interim replacements expense. If both full depreciation and amortization of capital were included in the power cost determinations, it would result in unwarranted duplication.

However, a certain amount of duplication is unavoidable, since it will be necessary to replace a part of the original facilities during the amortization period, as the result of physical or functional causes. The items replaced during the amortization period are referred to herein as interim replacements.

3. The term "interim replacement expense" has been adopted to differentiate this expense from depreciation expense of which it is a part. The interim replacement reserve to which the interim replacement expense annuity would be credited, is assumed to bear interest of 2½% compounded annually. The accruals to this reserve (including interest), are of such amount that during the 50-year amortization period they are estimated to exactly equal the original cost of all items replaced,1/ plus cost of removal, less salvage.

4. The determination of the annuity for interim replacements applicable to a 50-year amortization period beginning July 1, 1944 necessitates treating the replacements made prior to this date as expense items. It is necessary therefore to eliminate these costs from the total operating expenses as reported, when estimating operating expenses for the future; otherwise there would be some duplication in the annuity set up for interim replacements. This adjustment will be shown later in detail under the discussion of operating expenses.

Status of Development

5. The ultimate development of Bonneville Dam Project as now planned, is substantially complete. The house unit and the ten main generating units have been in operation since December 1943. The date each unit individually became operative is reported by the Corps of Engineers as follows:

1/ Items which are retired from capital but not replaced are not covered by the replacement annuity; however, the original cost of these items would be amortized.

Dates Units Became Operative

Kind and No.		Date Operative	Name Plate Rating (kw)
House unit	0	Sept. 28, 1937	4,000
Main unit	1	July 18, 1938	43,200
" "	2	June 6, 1938	43,200
" "	3	Jan. 9, 1941	54,000
" "	4	Dec. 23, 1940	54,000
" "	5	Sept. 5, 1941	54,000
" "	6	May 18, 1942	54,000
" "	7	March 31, 1943	54,000
" "	8	June 15, 1943	54,000
" "	9	Sept. 15, 1943	54,000
" "	10	Dec. 14, 1943	54,000
Total, Units 1 to 10, inclusive			518,400

6. Although a separate initial operation date is shown for each unit, the construction periods of units 3 to 6 inclusive and of units 7 to 10 inclusive overlapped, making precise division of costs impracticable. For the purposes of cost determination three dates were adopted, each being the average of the dates the units in the respective group went into operation. The date each group of units is considered to become operative, the corresponding direct costs, and the total costs, including interest during construction, are shown in Table 1.

7. The weighted average age, as of July 1, 1944, of the capital in each major account classification was as follows:

Classification	Weighted Average Age as of 7/1/44 Years
Navigation	5.95
Power	2.8
Joint	5.68
Total Capital	4.4

Procedure:

8. The more important steps followed in deriving the annuities for interim replacements are listed below:

(a) Preparation of a list of the property items included in the project;

(b) Determination of the direct costs chargeable against each class of items;

(c) Estimating the average life expectancy of each class of items in the project;

(d) Estimating, by items, the percent of investment that would be replaced during a 50-year period subsequent to initial installation, and of the weighted average date future replacements would occur;

(e) Estimating the average age of items as of July 1, 1944; and

(f) Calculation of an annuity sufficient, with interest, to equal the cost of each item replaced during the 50-year amortization period.

9. On February 24, 1944, a joint inspection of the Bonneville Dam Project was made by representatives of the Corps of Engineers, and the Federal Power Commission. Following this inspection estimates were made for each of the 123 items of property considered, of the percent of the investment in each item that would be retired from capital, and the time at which the replacement would occur. These estimates were based on a 50-year period beginning with the installation of each item.

10. Subsequently, the list of property items was increased to 144, and, on September 11, 12, and 13, 1944, representatives of the Corps of Engineers, the Bonneville Power Administration, the U. S. Bureau of Reclamation, and the Federal Power Commission met and reconsidered these former estimates. This group agreed upon the depreciation lives applicable to the Bonneville Dam Project, the amount of replacements that probably would be required during a 50-year amortization period, and the weighted average period after installation at which replacements would occur. The conclusions reached are summarized in Table 2, "Detailed list of major property units with estimates of Interim Replacements and Depreciation Lives."

11. The percentage of the total cost to be replaced and the replacement periods of many of the items listed in Table 2 are the same; therefore it was found convenient to group such items for the purpose of computing the annuities. Straight line and 2½ percent sinking fund annuity rates for these groups, twenty-five

in all, are shown in Table 3, "Interim Replacement Annuity Rates Compared." These annuities have been computed on two bases. The first is on the assumption that the amortization period for each item starts when the item becomes operative; the second, on the assumption that the amortization period for all items starts July 1, 1944. The effect of deferring the starting date for amortization is to increase considerably the amount of the annuity. This results from the fact that the initial and subsequent replacements occur earlier in the period, and from the fact that the number of replacements needed during the amortization period may be increased. The procedure followed in computing the annuities is illustrated in Table 4, "Typical Procedure followed in Estimating Interim Replacement Annuities."

12. Some parts of the Bonneville project were constructed nearly seven years prior to July 1, 1944. Inasmuch as it is not possible to make an accurate segregation of many of the items by operation dates it was necessary to estimate the number of years each group of items had been in operation prior to the focal date (July 1, 1944). In order to obtain conservative results, and to give some effect to the fact that the cost of removal has in the past exceeded the salvage value by at least 10 percent, an age of 7 years as of July 1, 1944, was adopted for the majority of the groups, excepting those pertaining to power plant equipment. For the latter, actual installation dates were used as a guide.

13. After calculating the annuity percentage rates for each group of items, the annuity applicable to each item of depreciable capital was computed by applying the rate to the book costs as recorded on June 30, 1944. The original computations were also based on starting the amortization period for each item at the time it became operative. Subsequently similar computations were made, assuming the amortization period to begin July 1, 1944.

14. A summary showing the results of the two computations is presented in Table 5, "Comparison of Interim Replacement Costs, based on Amortization period starting as property became operative, with costs based on period starting July 1, 1944." The costs shown under Column 2 pertain to items a part or all of which would be replaced one or more times in a 50-year period starting with the date each item becomes operative. Certain items take more than one annuity rate. In these instances the cost of the item appears in more than one group. An example is "Item 55 - Apartment Buildings including garages, heating plant, etc. - timber." This item is to be completely replaced in the 20th year with a more permanent structure. The present buildings are estimated to require replacements in the 10th year equal to 10 percent of the investment.

Two group rates were applied in this case, instead of setting up a special group for this item.

15. The 2½ percent sinking fund annuity needed for interim replacements, based on starting the 50-year amortization period when each item becomes operative, is $299,369 for power and joint facilities. If the annuity starts July 1, 1944 and extends over an amortization period 50 years from this date, then the total would be $360,455.

16. The book costs used in the detailed initial computations included "direct costs" only; a relatively minor amount of overhead and the allowance for interest during construction were omitted. Inasmuch as each item within a major account would be proportionately increased by these two cost elements, correction factors were applied to the original estimates. These factors are derived in Table 6, "Summary of Annuities Required for Interim Replacements (Amortization period starting July 1, 1944)." The new annuity, based on the inclusion of omitted overheads and Interest During Construction, 2½ percent sinking fund calculations, and starting the amortization period July 1, 1944, amounts to $374,235 for power and joint facilities.

17. Table 7, "Annuity for Interim Replacements Chargeable to Power on Basis of Various Allocations of Joint Capital," shows a range of annuities, considering various percentages of the joint facilities to be allocated to power. Inasmuch as the interim replacement costs on the joint facilities are relatively small, the amount of joint capital allocated to power does not materially affect the total amount of the power annuity.

Operating Expenses

18. As previously mentioned, in order to avoid the duplication of a portion of interim replacement costs in the estimates of future operating expenses, it is desirable to eliminate from the operating expenses of past years the replacements charged thereto. Table 8, "Amount of Replacement Costs Charged to Operating Expenses each Year," shows the operating expenses both as reported and with the interim replacements deducted. Retirements totaling $37,609.55[1/] were included in operating costs during the period January 1, 1938 through June 30, 1944.

19. Also included in the operating expenses shown for this period are the costs of extraordinary wartime defense precautions. These amounted to $79,591.37 during the fiscal year 1942; $106,124.99 during the fiscal year 1943; and $31,181.54 during the period July 1 to December 31, 1943.

1/ Total retirements during period prior to July 1, 1944, amounted to $276,499.80.

20. Uncleared overhead suspense items totalling $14,042.58, will be spread to expense accounts in the near future. This will increase the expenses shown for the period prior to July 1, 1944, by this amount. The distribution of this amount to major accounts is shown in Table 9.

Conclusions

1. In determining the average annual financial requirements for a 50-year amortization period beginning July 1, 1944, an allowance for interim replacements should be made in the amount of $375,000. This amount is based on the assumption that an interest rate of 2-1/2 percent is to be applied annually to the unamortized capital in calculating the interest expense. This amount is also based on the assumption that facilities will be retired from capital at original cost, and that new capital additions and replacements will be entered on the books at current costs.

2. The interim replacement annuities are assumed to be charged to an interim replacement reserve which bears interest at 2-1/2 percent per annum. When facilities are replaced, the original cost, less net salvage, is charged against this reserve. This reserve does not cover abandoned property.

3. Replacements made prior to July 1, 1944, have been charged directly to maintenance expense; these totalled $37,609.55. Consideration should be given to these charges when estimating future operating expenses, in order to avoid duplication of interim replacement costs. Unclassed suspense items totalling $14,042.58 will partially offset this amount.

/s/ Lesher S. Wing

Lesher S. Wing
Senior Engineer

20. Uncleared overhead suspense items totalling $14,042.58, will be spread to expense accounts in the near future. This will increase the expenses shown for the period prior to July 1, 1944, by this amount. The distribution of this amount to major accounts is shown in Table 9.

Conclusions

1. In determining the average annual financial requirements for a 50-year amortization period beginning July 1, 1944, an allowance for interim replacements should be made in the amount of $375,000. This amount is based on the assumption that an interest rate of 2-1/2 percent is to be applied annually to the unamortized capital in calculating the interest expense. This amount is also based on the assumption that facilities will be retired from capital at original cost, and that new capital additions and replacements will be entered on the books at current costs.

2. The interim replacement annuities are assumed to be charged to an interim replacement reserve which bears interest at 2-1/2 percent per annum. When facilities are replaced, the original cost, less net salvage, is charged against this reserve. This reserve does not cover abandoned property.

3. Replacements made prior to July 1, 1944, have been charged directly to maintenance expense; these totalled $37,609.55. Consideration should be given to these charges when estimating future operating expenses, in order to avoid duplication of interim replacement costs. Unclassed suspense items totalling $14,042.58 will partially offset this amount.

/s/ Lesher S. Wing

Lesher S. Wing
Senior Engineer

Table 1

Bonneville Dam Project

Cost as of June 30, 1944

with Estimated Cost to Complete

Stage of Development	Navigation	Power Facilities	Joint Facilities	Total Project
First Step (Operative 7-1-38)		(Units 0, 1, & 2)		
Direct Costs	5,418,181	8,759,167	34,904,897	49,082,245
Total incl. I.D.C.	5,708,814	9,229,013	36,777,211	51,715,038
Second Step (Operative 7-1-41)		(Units 3, 4, 5, & 6)		
Direct Costs	66,459	11,578,457	2,555,084	14,200,000
Total incl. I.D.C.	68,613	11,953,587	2,637,865	14,660,065
Third Step (Operative 8-1-43)		(Units 7, 8, 9, & 10)		
Direct Costs to date	5,704	15,992,961	619,491	16,618,156
Total incl. I.D.C. to date	5,850	16,401,818	635,328	17,042,996
Est. Additional Direct Cost	7,195	650,482	366,290	1,023,967
Total Add. incl. I.D.C.	7,285	658,613	370,869	1,036,767
Total 3rd Step incl. I.D.C.	13,135	17,060,431	1,006,197	18,079,763
Total as of 6-30-44 plus estimated cost to complete		(Units 0 - 10 incl.)		
Direct Costs	5,497,538	36,981,067	38,445,762	80,924,367
Total incl. I.D.C.	5,790,561	38,243,031	40,421,274	84,454,866
Weighted Average ($-months basis) as of 7-1-44	71.4	33.6	68.1	52.7

I.D.C. = Interest during construction.

Table 2
Bonneville Dam Project
Detailed List of Major Property Units with Estimates of Interim Replacements and Depreciation Lives
(Amortization Period Assumed to Start When Property Becomes Operative)

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	Depreciation Life Estimate (years)
-	Lands	None	None
*	Flowage Easements	None	100
*	Railroad Relocations	None	100
*	Highway and Other Relocations	None	100
*	Protective Works, The Dalles	None	100
*	Reservoir Bank Protection	None	100
*	Grading, Miscellaneous	None	100
*	Well Drilling, etc.	None	100
*	Concrete Levee Retaining Walls	None	100
1.	Powerhouse Structure, including excavation, etc.	None	100
2.	Fishway Structures - Concrete	None	100
3.	Tanner Creek Fishladder Structure	Consolidate with Item 2.	
4.	Spillway Dam - Structure, incl. excavation, etc.	None	100
6.	Concrete Substations	Consolidate with Item 8.	
7.	Concrete Bridges, roadway	None	60
8.	Concrete Control houses, etc.	None	50
9.	Concrete Manholes, Catchbasins	75% in 35 years (1 cycle)	40
10.	Concrete and Tile Sewer Pipe	1 cycle in 20 years	20 1/
11.	Concrete Stoplogs	1 cycle in 50 years (Abandon in 6th year)	50
12.	Concrete Paved Roads, Walks	2 cycles, 20 years each	20
*	Concrete Retaining Wall		100
13.	Brick Buildings	Consolidate with Item 15.	
14.	Hollow Tile Partition Walls	20% in 25 years (1 cycle)	30
15.	Brick Buildings, timber framed	1 cycle, 35 years	35
16.	Exposed Structural Steel, Iron	10% in 25 years (1 cycle)	50
17.	Submerged Steel, Iron	1 cycle, 30 years	30
18.	Steel Tower and Cable River Gauges	None (non-replaceable)	100
19.	Steel Crane and Gate Rail	None	100
20.	Steel Stoplogs	None	75
21.	Galv. Steel Transmission, Bus Structures	None	50
22.	Steel Repair Caissons	1 cycle, 20 years	20 2/

Table 2
Bonneville Dam Project
Detailed List of Major Property Units with Estimates of Interim Replacements and Depreciation Lives
(Amortization Period Assumed to Start When Property Becomes Operative)

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	Depreciation Life Estimate (years)
-	Lands	None	None
*	Flowage Easements	None	100
*	Railroad Relocations	None	100
*	Highway and Other Relocations	None	100
*	Protective Works, The Dalles	None	100
*	Reservoir Bank Protection	None	100
*	Grading, Miscellaneous	None	100
*	Well Drilling, etc.	None	100
*	Concrete Levee Retaining Walls	None	100
1.	Powerhouse Structure, including excavation, etc.	None	100
2.	Fishway Structures - Concrete	None	100
3.	Tanner Creek Fishladder Structure	Consolidate with Item 2.	
4.	Spillway Dam - Structure, incl. excavation, etc.	None	100
6.	Concrete Substations	Consolidate with Item 8.	
7.	Concrete Bridges, roadway	None	60
8.	Concrete Control houses, etc.	None	50
9.	Concrete Manholes, Catchbasins	75% in 35 years (1 cycle)	40
10.	Concrete and Tile Sewer Pipe	1 cycle in 20 years	20 1/
11.	Concrete Stoplogs	1 cycle in 50 years (Abandon in 6th year)	50
12.	Concrete Paved Roads, Walks	2 cycles, 20 years each	20
*	Concrete Retaining Wall		100
13.	Brick Buildings	Consolidate with Item 15.	
14.	Hollow Tile Partition Walls	20% in 25 years (1 cycle)	30
15.	Brick Buildings, timber framed	1 cycle, 35 years	35
16.	Exposed Structural Steel, Iron	10% in 25 years (1 cycle)	50
17.	Submerged Steel, Iron	1 cycle, 30 years	30
18.	Steel Tower and Cable River Gauges	None (non-replaceable)	100
19.	Steel Crane and Gate Rail	None	100
20.	Steel Stoplogs	None	75
21.	Galv. Steel Transmission, Bus Structures	None	50
22.	Steel Repair Caissons	1 cycle, 20 years	20 2/

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	*Depreciation Life Estimate (years)
23.	Submerged Gates, Valves	1 cycle, 25 years	25
24.	Steel Floor Gratings, Deck Plates	None	50
25.	Steel Trash Screens, Racks	1 cycle, 35 years	35
26.	Steel Water Storage Tanks	None	50
27.	Steel Oil Storage Tanks (in Powerhouse)	10%, 30 years (1 cycle)	50
27a.	Steel Gasoline Storage Tanks (underground)	1 cycle, 30 years	30
28.	Steel Fencing, Gates, Posts	3 cycles, 15 years each	15
29.	Sheet Metal Roofs, Gutters (copper)	2 cycles, 20 years each	20
30.	Galv. W.I. Heating Pipe, Fittings	1 cycle, 40 years	40
31.	Galv. W.I. Corrugated Culvert	1 cycle, 35 years	35
32.	Exposed Steel, Iron Castings	None	50
33.	Plate Steel Pipe, Penstocks	None	75
34a.	Interior Piping and Plumbing (Powerhouse)	10% in 25 years, cont.	50
34b.	Outside Piping and Plumbing, incl. Septic Tanks, etc.	1 cycle, 35 years	35
35.	Pipe and Chain Hand Rail, Stanchions	1 cycle, 40 years	40
36.	Lawn Sprinkler System	2 cycles, 20 years each	20
37.	Steel and Timber Fish Traps, Barriers	3 cycles, 15 years each	15
38.	Swing Bridge Steel Str.		40
39.	Powerhouse Intake Gates (steel)	None	75
40.	Spillway Dam Gates (steel)	None	75
40a.	Spillway Temporary Supplemental Gate Sections	None (Abandon)	10
41.	Shiplock Mitre Gates		75
42a.	Exposed and Submerged Oak Timber	2 cycles, 20 years each	20
42b.	Oak Crane Rail Sleepers	1 cycle, 40 years	40
43.	Timber Stoplogs (Douglas fir)	3 cycles, 15 years each	15
44.	Timber Gratings, Baffles	2 cycles, 20 years each	20
45.	Log Booms, Floats, Rafts	4 cycles, 10 years each	10
46.	Creosoted Timber Piling (Pylons)	None (part of foundations)	
46a.	Creosoted Piling Foundations		100
47.	Wooden River Gauges	5 cycles, 1st 8 years then 10 each	8
48.	Wooden Water Storage Tanks	None (to be abandoned)	20
49.	Railway Trestle		15
50.	Railway Bridge Decking		10
51.	Wooden Shelters, light Constr.	3 cycles, 15 years each	15
52.	Residences, Washington Shore (timber) (Abandon in 20th year)	20% in 10 years (1 cycle)	20
53.	Residences, Bonneville (timber)	30% in 25 years, cont.	40
54.	Residence, Hill House (timber)	None (to be abandoned)	15

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	Depreciation Life Estimate (years)
55.	Apartment Buildings, incl. Garages, Heating Plant, etc. (timber)	20% in 10 years, 1 cycle; (Replace in 20th year, 1 cycle)	20
56.	Greenhouse, timber framed	2 cycles, 20 years each	20
57.	Generators and controls	55% in 28 years, cont.	35
58.	Oil Circuit Breakers	1 cycle, 35 years	35
59.	Transformers, Station and Transmission	1 cycle, 35 years	35
60.	Transformers, Distribution	2 cycles, 20 years each	20
61.	Switchboards, Cubicles	1 cycle, 35 years	35
62.	Recording Instruments	1 cycle, 20 years	20
63.	Electric Signal Devices	3 cycles, 15 years each	15
64.	Communication Equipment, incl. Carrier phone, Radiophone	3 cycles, 15 years each	15
65.	Enclosed Switchgear, Bus	10% in 30 years (1 cycle)	50
66.	Lightning Arresters	50% in 25 years, cont.	25
67.	Airbreak Switches	3 cycles, 15 years each	15
68.	High Tension Disconnects	1 cycle, 35 years	35
69.	Potential Transformers	1 cycle, 30 years	30
70.	Current Transformers	1 cycle, 30 years	30
71.	Neutral Grounding Reactors	1 cycle, 35 years	35
72.	Meters, Distribution	1 cycle, 30 years	30
73.	Elec. Motors and Controls		25
74.	Wiring and Conduit, Control	50% in 25 years (2 cycles)	35
75.	Wiring and Control, Power	50% in 25 years (2 cycles)	35
76.	Lighting Fixtures, Conductors, Conduit-Interior	75% in 25 years (2 cycles)	30
77.	Lighting Fixtures, Conductors, Conduit-Exterior	50% in 25 years (2 cycles)	30
78.	Aviation Beacons, Floodlights Searchlights, etc.	3 cycles, 10,15,20 years	10
79.	Traffic Warning & Control Device		50
80.	Storage Batteries, incl. Racks	4 cycles, 10 years each	10
81.	Storage Battery Chargers	1 cycle, 30 years	30
82.	Gasoline-powered Motor Generators	1 cycle, 25 years	25
83.	Laboratory and Testing Equipment	3 cycles, 15 years each	15
84.	Distribution Lines, underground	2 cycles, 15, 20 years	15
85.	Distribution Lines, overhead, wood pole	1 cycle, 20 years	20
86.	Heating: Controls, elements, conductors	3 cycles, 15 years each	15
87.	Heating Units, residential type	1 cycle, 12 years and 2 cycles, 15 years each	12
88.	Electric water heaters, monel tank	2 cycles, 20 years each	20
89.	Electric ranges	3 cycles, 15 years each	15
90.	Electric Refrigerators	3 cycles, 15 years each	15

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	Depreciation Life Estimate (years)
91.	Hydraulic turbines (Kaplan)	50% in 40 years, cont.	47
92.	Turbine Governors, actuators	1 cycle, 35 years	35
93.	Pumps and Controls, Sump (steady use)	1 cycle, 35 years	35
94.	Pumps and controls, deep well (intermittent use)	1 cycle, 35 years	35
95.	Pumps and controls, oil circulating	None	50
96.	Electric Cranes and Derricks	10% in 25 years, cont.	50
97.	Electric Hoists	1 cycle, 35 years	35
98.	Hand Hoists	1 cycle, 30 years	30
99.	Electric Elevators	50% in 30 years, cont.	50
100.	Air Compressors and controls	50% in 35 years, cont.	50
101.	Manometers, Flowmeters, Piezometers	15% in 5 years; 50% in 40	35
102.	Machine Shop Tools, Equipment	75% in 45 years, cont.	35
103.	Oil Filters and Separators, fixed	1 cycle, 40 years	40
104.	Oil Filters and Separators, portable	2 cycles, 20 years each	20
105.	Electric Ventilating Blowers, fans	1 cycle, 30 years	30
106.	CO_2 Fire Extinguishing System, fixed	10% in 30 years, cont.	50
107.	Electric Sewage Pumps	1 cycle, 35 years	35
108.	Oxygen Inhalators	3 cycles, 15 years each	15
109.	Shiplock Gate Machinery		35
110.	Swing Bridge Operating Machinery		25
111.	Travelling Water Screens and Misc. Submerged Equipment	2 cycles, 20 years each	20
112.	Rubber Seals, exposed and submerged	3 cycles, 15 years each	15
113.	Exposed Copper, Bronze Brass	10% in 25 years, cont.	50
114.	Fiber Conduit	None	75
115.	Canvas	None (to be abandoned)	6
116.	Office Furniture, Fixtures	1 cycle, 25 years	25
117.	Hand-placed Riprap	None	100
118.	Gravelled Roads, Walks	None (to be abandoned)	8
119.	Bituminous Paved Roads, Walks	1 cycle, 40 years	40
120.	Vitreous Flooring Tile	None	75
121.	Rubber and Aspholt Flooring Tile	2 cycles, 20 years each	20
122.	Submerged Vitrious Tile Gauges		50
123.	Service Railroad Track	50% in 25 years, cont.	30
124.	Link Belt Drive Chain		10
125.	Enamel Metal Signs	3 cycles, 15 years each	15
126.	Decompression Chamber (Divers)	1 cycle, 40 years	40
127.	Platform Scales, Heavy Duty	None	50
128.	Hydraulic Car Hoists, automotive	None	50
129.	Electric Gasoline Service Pumps	2 cycles, 20 years each	20

Bonneville Property Unit No.	Item	Interim Replacement Estimate: 50-year period	Depreciation Life Estimate (years)
130.	Portable Fire Extinguishers, Foamite, CO_2	3 cycles, 15 years each	15
131.	Portable Fire Extinguishers Pyrene, etc.	3 cycles, 15 years each	15
131a.	Motor Scooter	3 cycles, 15 years each	15

1/ Replace with long life item.
2/ Replace with 30 ± yr. item.

Table 3
Bonneville Dam Project
Interim Replacement Annuity Rates Compared

Group	Rates Based Starting Annuity When Item is Operative		Replacement Periods	Rates Based on Starting Annuities 7/1/44	
	St. Line	2½% S.F.		St. Line	2½% S.F.
(1)	(2)	(3)	(4)	(5)	(6)
1	.04	.02928	25 yr An.	.0456	.0376
2	.02	.02152	1 cy-20 yr	.03	.031
3	.04	.03465	2 cy-20 yr	.04	.04123
4	.0172	.02841	6 yr-Ab.	.02	.03526
5	.02	.01486	1 cy-35 yr	.02	.0190
6	.02	.01902	1 cy-25 yr	.02	.0226
7	.04	.02928	2 cy-25 yr	.04	.0348
8	.02	.01681	1 cy-30 yr	.02	.02
9	.06	.05276	3 cy-15 yr	.06	.0628
10	.06	.05819	3 cy-10-15-20	.06	.0692
11	.08	.07900	4 cy-10 yr	.10	.1063
12	.04	.03920	2 cy-15-20	.05	.052
13	.06	.05682	3 cy-12-15-15	.07	.0728
14	.02	.03116	1 cy-5 yr	.02	.0353
15	.02	.01313	1 cy-40 yr	.02	.0156
16	.02222	.01227	45 yr An.	.025	.0131
17	.02	.02894	1 cy-8 yr	.02	.0353
18	.1000	.09378	5 cy)8-18-)28-38)-48	.10	.09378
19	.02	.02754	1 cy-10 yr	.022	.0289
20	.02	.0243	1 cy-15 yr	.02	.02897
21	.0294	.02509	Composite	.0310	.02901
22	.03333	.02278	30 yr An.	.037	.0234
23	.013	.01124	) 15%-5 yr) 50%-40 yr	.013	.0127
24	.0207	.01484	Composite	.02145	.01761
25	.0286	.01821	35 yr An.	.0323	.02158

Table 4
Bonneville Dam Project
Typical Procedure Followed in Estimating
Interim Replacement Annuities

Group 3 — 2 cycles - 20 years each

First Case: Assume annuity for replacement starts when unit becomes operative.

(1) Present worth of $1.00 20 years hence = $.610271 (1st Replacement)
(2) " " of $1.00 40 years " = $.372431 (2nd Replacement)
(3) Total present worth of 2 replacements $.982702
(4) 50 year annuity purchasable with $1.00 interest at 2-1/2% $.0352581
(5) Replacement annuity rate 2-1/2% S.F. basis: .982702 x .0352581 = $.0346482
(6) Replacement annuity rate st. line basis: $\frac{2.00}{50}$ = $.04

Second Case: Assume annuity for replacement starts 7 years after units become operative

(1) Present worth of $1.00, 13 years hence = $.725420 (1st Replacement)
(2) " " of $1.00, 33 " " = $.442703 (2nd Replacement)
(3) Total Present worth of 2 replacements $1.168123
(4) 50 year annuity purchasable with $1.00, interest at 2-1/2% $ .0352581
(5) Replacement annuity rate 2-1/2% S.F. basis: 1.168123 x .0352581 =$ .0411858
(6) Replacement annuity st. line basis: $\frac{2.00}{50}$ =$ .04*

* If a replacement occurs before the twenty third year of the amortization period then the annuity will be less for straight line than for 2-1/2 percent sinking fund for that replacement, and may reduce the composite annuity below that computed on the sinking fund basis.

Table 5
Bonneville Dam Project
Interim Replacement Costs Based on Amortization Period Starting as Property Becomes Operative Compared with Costs Based on Period Starting July 1, 1944

Group	Direct Cost of Items Included in Study 5/	Amount in Col. (1) Subject to Replacement	Annuity to Start When Item is Operative: Straight Line Percent	Straight Line Amount $	2-1/2% Sinking Fund Percent	2-1/2% Sinking Fund Amount $	Annuity to Start July 1, 1944: Straight Line Percent	Straight Line Amount $	2-1/2% Sinking Fund Percent	2-1/2% Sinking Fund Amount $
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	1,838,321	247,119	4.000	9,885	2.928	7,236	4.56	11,269	3.76	9,292
2	1/ 277,987	277,988	2.000	5,560	2.152	5,982	3.00	8,340	3.10	8,618
3	239,997	239,997	4.000	9,600	3.465	8,316	4.00	9,600	4.123	9,487
4	-	-	-	-	-	-	-	-	-	-
5	4,583,920	4,582,914	2.000	91,658	1.486	68,102	2.00	91,658	1.90	87,075
6	1,416,384	291,971	2.000	5,839	1.902	5,553	2.00	5,839	2.26	6,599
7	542,517	295,453	4.000	11,818	2.928	8,651	4.00	11,818	3.48	10,282
8	1,148,755	166,451	2.000	3,329	1.681	2,798	2.00	3,329	2.00	3,329
9	260,905	260,905	6.000	15,654	5.276	13,765	6.00	15,654	6.28	16,385
10	11,343	11,343	6.000	681	5.819	660	6.00	681	6.92	785
11	19,160	19,160	8.000	1,533	7.900	1,514	10.00	1,916	10.63	2,037
12	57,001	57,001	4.000	2,280	3.920	2,234	5.00	2,850	5.20	2,964
13	11,603	11,603	6.000	696	5.682	675	7.00	812	7.28	845
14	3/ 23,209	3,481	2.000	70	3.116	108	2.00	70	3.53	123
15	4/ 227,742	216,138	2.000	4,323	1.313	2,838	2.00	4,323	1.56	3,372
16	58,925	44,194	2.222	982	1.227	542	2.50	1,105	1.31	579
17	4,264	4,264	2.000	85	2.894	123	2.00	85	3.53	151
18	238	238	10.000	24	9.378	22	10.00	24	9.378	22
19	2/ 63,117	12,823	2.000	256	2.754	353	2.20	282	2.89	371
20	-	-	-	-	-	-	-	-	-	-
21	7,749,334	4,262,133	2.94	125,306	2.509	106,937	3.10	132,126	2.901	123,644
22	173,419	59,432	3.333	1,981	2.278	1,354	3.70	2,199	2.338	1,390
23	-	-	-	-	-	-	-	-	-	-
24	8,266,989	4,133,494	2.07	85,563	1.484	61,341	2.145	88,663	1.761	72,791
25	29,120	14,560	2.86	416	1.821	265	3.23	470	2.158	314
Total				377,539		299,369		393,113		360,455

1/ 58,560 of this amount is also listed under Group 19.
2/ 58,560 " " " " " " " Group 2
3/ 23,209 " " " " " " " Group 15
4/ 23,209 " " " " " " " Group 14
5/ Based on book costs reported on 6/30/44 and is exclusive of Interest During Construction and a minor amount of overhead. Cost of nondepreciable items, and of items having a life of over 50 years are not included.

Table 6
Bonneville Dam Project
Summary Of Annuities Required For Interim Replacements
(Amortization Period Starting July 1, 1944)

Major Account Classification	Book Cost 6-30-44 Plus Cost to Complete (Excluding I.D.C.) Original Est.	Book Cost 6-30-44 Plus Cost to Complete (Excluding I.D.C.) Final Est.	Total Cost Incl. I.D.C. Final Est.	Ratio Col.4÷Col.2	Interim Replacement Annuity Basis Col.2	Interim Replacement Annuity Basis Col.4	Composite Annuity Rate Col.7÷Col.4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NAVIGATION FACILITIES	5,497,351	5,497,538	5,790,561	1.053337	(Not Est.)	(Not Est.)	(Not Est.)
POWER FACILITIES							
Generation	34,388,289	34,445,898	35,623,866	1.035930	258,308	267,589	.007512
Transmission	2,522,046	2,531,481	2,615,357	1.036998	42,092	43,649	.016689
Distribution	3,687	3,688	3,808	1.032818	150	155	.040704
Total Power Facilities	36,914,022	36,981,067	38,243,031	1.036003	300,550	311,393	.008142
JOINT FACILITIES							
Spillway Dam & Reservoir	28,001,426	28,001,800	29,454,042	1.051877	17,035	17,919	.000608
Bradford Is. Closure	2,024,365	2,024,365	2,125,868	1.050141	1,046	1,098	.000516
Total Dam & Reservoir	30,025,791	30,026,165	31,579,910	1.051759	18,081	19,017	.000602
Fishways	7,274,681	7,276,263	7,647,944	1.051310	22,511	23,666	.003094
Buildings & Grounds	1,143,325	1,143,334	1,193,420	1.043815	19,313	20,159	.016892
Total Joint Facilities	38,443,797	38,445,762	40,421,274	1.051438	59,905	62,842	.001555
Total All Facilities Excluding Navigation	75,357,819	75,426,829	78,664,305	1.043877	360,455	374,235	.004757
Grand Total All Facilities	80,855,170	80,924,367	84,454,866	1.044520	(Not Est.)	(Not Est.)	(Not Est.)

Table 7
Bonneville Dam Project
Annuity for Interim Replacements Chargeable to Power
on Basis of Various Allocations of Joint Capital
(2-1/2 percent S.F. Basis)

Joint Facilities	Percentage of Joint Facilities Allocated to Power									
Percentage Allocated to Power	10	20	30	40	50	60	70	80	90	100
Replacement Annuity Allocated to Power	6,284	12,568	18,853	25,137	31,421	37,705	43,989	50,274	56,558	62,842
Direct Power Facilities										
Replacement Annuity	311,393	311,393	311,393	311,393	311,393	311,393	311,393	311,393	311,393	311,393
Total Chargeable to Power	317,677	323,961	330,246	336,530	342,814	349,098	355,382	361,667	367,951	374,235

Table 8
Bonneville Dam Project
Amount of Replacement Costs
Charged to Operating Expenses Each Year
(Period 1/1/38 to 6/30/44)

		Navigation	Power	Joint	Total
Operation:					
1938		4,134.32	1,609.71	19,474.93	25,218.96
1939		11,355.92	37,622.02	63,882.19	112,860.13
1940		13,151.06	46,415.38	58,808.37	118,374.81
1941		15,681.92	34,930.22	88,466.64	139,078.78
1942		38,977.03	121,122.71	133,393.47	293,493.21
1943		46,835.86	164,086.28	132,767.80	343,689.94
1944		34,739.58	197,502.39	111,025.44	343,267.41
	Total	164,875.69	603,288.71	607,818.84	1,375,983.24
Maintenance:					
1938	As reported	2,994.92	-	6,173.78	9,168.70
	Less: Charges to Depr. Reserve	-	-	-	-
		2,994.92	-	6,173.78	9,168.70
1939	As reported	13,192.59	40,752.96	56,812.61	110,758.16
	Less: Charges to Depr. Reserve	-	-	-	-
		13,192.59	40,752.96	56,812.61	110,758.16
1940	As reported	45,991.02	50,833.87	84,786.70	181,611.59
	Less: Charges to Depr. Reserve	2,984.37	4,153.73	16,870.42	24,008.52
		43,006.65	46,680.14	67,816.28	157,603.07
1941	As reported	28,157.89	41,003.16	88,006.30	157,167.35
	Less: Charges to Depr. Reserve	1,350.68	1,713.52	6,070.45	9,134.65
		26,807.21	39,289.64	81,935.85	148,032.70
1942	As reported	18,977.48	33,316.72	46,063.82	98,358.02
	Less: Charges to Depr. Reserve	243.05	-1 59.39	-25.45	58.21
		18,734.43	33,476.11	46,089.27	98,299.81
1943	As reported	15,300.36	40,717.26	57,135.67	113,153.29
	Less: Charges to Depr. Reserve	3,377.32	160.80	547.12	4,085.24
		11,923.04	40,556.46	56,588.55	109,068.05
1944	As reported	39,565.85	114,189.44	105,653.81	259,409.10
	Less: Charges to Depr. Reserve	233.25	-	89.68	322.93
		39,332.60	114,189.44	105,564.13	259,086.17
	Total Maintenance, as reported	164,180.11	320,813.41	444.632.69	929,626.21
	Less: Charges to Depr. Reserve	8,188.67	5,868.66	23,552.22	37,609.55
		155,991.44	314,944.75	421,080.47	892,016.66

Data supplied by:
U.S. Engineer Office
Portland, Oregon.
4 December 1944
Revised: 18 December 1944

Table 9
Bonneville Dam Project
Distribution of Uncleared Overheads
Chargeable to Operation and Maintenance
(Period Prior to 7/1/44)

	F.Y. 1943	F.Y. 1944	Total
Operation:			
Navigation	351.47	597.79	949.26
Power			
Generation	1,432.64	3,258.84	4,691.48
Transmission	162.96	289.46	452.42
	1,595.60	3,548.30	5,143.90
Joint			
Dam, Reservoir	393.95	720.34	1,114.29
Fishways	327.29	476.10	803.39
Buildings, Grounds	430.00	687.99	1,117.99
	1,151.24	1,884.43	3,035.67
Total, Operation	3,098.31	6,030.52	9,128.83
Maintenance			
Navigation	80.13	654.35	734.48
Power			
Generation	112.36	1,695.87	1,808.23
Transmission	19.31	85.52	104.83
Distribution	-	-	-
	131.67	1,781.39	1,913.06
Joint			
Dam, Reservoir*	265.89	926.92	1,192.81
Fishways	193.69	429.69	623.38
Buildings, Grounds	57.33	392.69	450.02
	516.91	1,749.30	2,266.21
Total, Maintenance	728.71	4,185.04	4,913.75
Total, Oper. and Maint.	3,827.02	10,215.56	14,042.58
* Includes charges to Brad. Slough Closure:	12.29	19.47	31.76

Data supplied by:
U.S. Engineer Office
Portland, Oregon
15 December 1944

Note: Reported operation and Maintenance expenses do not include above overheads.

EXHIBIT 10
(1 Sheet)

Bonneville Project
Columbia River, Oregon-Washington

NORMAL ANNUAL OPERATION AND MAINTENANCE COSTS

As Estimated by the U.S. Engineer Department
and Reported to the Commission by
the Deputy Chief of Engineers

Powerhouse			
Operation	$170,000		
Credit, Other Departments	- 10,000		
	$160,000		
Maintenance	94,000	$254,000	
Transmission (Station)			
Operation	$ 17,500		
Maintenance	6,000	23,500	
Total, Power Plant			$277,500
Dam and Reservoir			
Operation	$ 25,000		
Maintenance	127,500	$152,500	
Fishways			
Operation	$ 25,000		
Maintenance	15,000	40,000	
Buildings and Grounds			
Operation	$ 45,000		
Maintenance	7,500	52,500	
Total, Joint Facilities			245,000
Total, Power Facilities and Joint Facilities			$522,500
Navigation Facilities			
Operation	$ 20,000		
Maintenance	30,000		50,000
Grand Total			$572,500
Total Project:			
Operation			$292,500
Maintenance			280,000
Grand Total			$572,500 1/

1/ Does not include annual costs for interim replacements.

EXHIBIT 12
(1 Sheet)

Energy Generation
Bonneville and Grand Coulee Power Plants
Prior to July 1, 1944

Fiscal Year Ended June 30	Kilowatt-hours	
	Bonneville	Grand Coulee
1939	34,202,800	--
1940	208,059,100	--
1941	894,214,500	7,455,000
1942	1,807,309,000	741,821,500
1943	2,801,480,400	2,816,955,800
1944	3,488,874,000	5,750,949,600
Total	9,234,139,800	9,317,181,900